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MARION & POLK COUNTY REGIONAL ENVIRONMENTAL SCAN ASSESSMENT FOR ENVIRONMENTAL HEALTH RESILIENCY

Prepared for: Marion County Health & Human Services and Polk County Health Services

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Contents

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Acronyms

ADA: Americans with Disabilities Act
CDC: Centers for Disease Control and Prevention
CDSPC: Centro de Services Para Campesino
CHA: Community Health Assessments
CHIP: Community Health Improvement Plans
CoC: Continuum of Care
CP: Community Partners
D/HH: deaf or hard of hearing
DEQ: Department of Environmental Quality
EHHT: environmental health hazards and threats
EJ: environmental justice
EM: Emergency Management
EPA: Environmental Protection Agency
HAB: harmful algal blooms
HUD: US Department of Housing and Urban Development
HVAC: heating, ventilation, and air conditioning
IDD: Intellectual and Developmental Disability / Intellectually and Developmentally Disabled
IMM: Integrated Mosquito Management
MAPP: Mobilization for Action through Planning and Partnership
MPCHD: Marion and Polk County Health Departments
ODWT: Oregon Domestic Well Testing (Map)
OHA: Oregon Health Authority
OREM: Office of Resiliency and Emergency Management
PBB: personal protective behaviors
PGE: Portland General Electric
PM: Particulate Matter
RAPP: Relatives as Parents Program
RQA: rapid qualitative analysis
SFR: Salem for Refugees
SWOT: strengths, weaknesses, opportunities, threats
USFS: US Department of Agriculture Forest Service
USGS: US Geological Survey
VOCs: volatile organic compounds
VP: vulnerable population
WNV: West Nile Virus
WUI: wildland-urban interface

Executive Summary

Marion and Polk Counties have experienced a number of unprecedented environmental events recently. For example, the 2018 Algal Bloom at Detroit Lake impacted drinking water in the City of Salem for a month. The 2020 Labor Day Fires in the Santiam Canyon resulted in local fatalities, loss of property and landscapes, and dramatically reduced air quality for much of the region. The February 2021 Ice Storm that hit much of the Willamette Valley left many residents without power for upwards of one week, while the Heat Dome that occurred several months later in July of that year set all-time record highs, with temperatures reaching 117°F. These events, known in this report as Environmental Health Hazards and Threats (EHHTs), have direct and indirect impacts on those who live and work in Marion and Polk Counties.

In recognition of the impacts of EHHTs on the health of Oregon communities, the Oregon Health Authority requires public health authorities in the state to better support community adaptation and resilience to these events. OHA has also provided funds to local health authorities including those in Marion and Polk Counties to accomplish this as part of Goal 3 of Program Element (PE) #51 of Public Health Modernization. The work presented in this report is the initial phase to identify community resources and needs in this planning effort, which will bolster the climate adaptation plans being developed by health departments in Marion and Polk Counties. Specifically, this project addresses the following research questions developed at by the local health authorities:

- What community and government programs, services, policies, and efforts currently exist in Marion County and Polk County to address vulnerable populations' resilience to EHHTs?
- What local reports, data, and research currently exists highlighting the EHHTs that affect residents, visitors, and people employed in Marion County and Polk County?
- What information has been communicated and is being communicated to vulnerable populations in Marion County and Polk County about EHHTs and through what means of communication (such as television, newspaper, radio, social media, organizational communication)?
- What are the strengths, weaknesses, opportunities, and threats among community and government programs and efforts to address vulnerable populations' resilience to environmental health hazards and threats?

This report is the result of a collaborative partnership between Willamette University, Marion County Health and Human Services, and Polk County Health Services. A Civic-

Engaged Learning model allowed for the meaningful integration of research and data collection into twelve university-level classes in the departments of Environmental Science, Public Health, Politics, and English. The methods used to answer the above research questions include: interviews with Community Partners and Leaders, an online community survey available to anyone that lives or works in Marion or Polk County, focus groups with members of specific populations that may be more impacted by EHHT events, media and communication analysis, as well as the review and analysis of GIS data, academic and gray literatures, and relevant programs and policies. This report also includes many hyperlinks that point readers towards useful reports, policies, programs or other materials that may be useful in developing local priorities and tools.

Emergent Key Findings Emerged from this Project:

- Past EHHT events presented logistical, financial, operational challenges to many community partners as they tried to meet the needs of populations they serve.
- The recent experiences with EHHT events have prompted a desire for many community partners to move from reactive responses to EHHTs towards more proactive planning.
- The smoke from the 2020 Labor Day Fires and the 2021 Ice Storm had the greatest general impact on community survey respondents.
- Community survey respondents also described logistical and financial challenges during EHHTs even as a significant portion also described physical and mental health impacts.
- Community survey respondents are most concerned about the impacts of wildfire smoke / poor air quality, winter storms, and heat negatively impacting them over the next five years. They are least concerned about vector-borne diseases and flooding impacts.
- Approximately half (48.5%) of survey respondents were signed up for Marion-Polk Alerts. There was a strong preference for internet and phone-based information by many participants. Government sources were also highly rated, however past experience with inconsistent messaging has eroded the trust of some in these sources.
- Increased access to communication and information during and about EHHT events in languages other than English was expressed by both community participants and community partners.

Based on the findings of the report, we provide the following general recommendations to support environmental health adaptation and resilience in Marion and Polk Counties. More

detailed recommendations, including those pertaining to specific EHHT events, can be found in the Overarching Findings and Recommendations section of this report.

Recommendations on the Role of Public Health:

- Preparing for and managing through EHHTs would benefit from an explicit social determinants of health approach.
- Health equity should be a constant frame through which to allocate resources and target communication.
- The public health departments of Marion and Polk Counties are well positioned to facilitate opportunities for Community Partners to improve their understanding of EHHTs and create improved communication networks for resilience.

Recommendations on EHHT Communications Planning

- A communication plan should be developed for each EHHT and updated on a predictable cycle.
- EHHT communication must continue to be a multi-pronged, multi-media approach.
- EHHT materials should be made available in all languages.
- EHHT materials should be improved with respect to accessibility.
- Communication plans should articulate well-timed preparation messaging on an annual basis.

Part 1: Introduction

The local public health authorities (LPHA) of Marion and Polk County have consistently engaged in Public Health Modernization efforts. Specifically, these two LPHAs have used the Mobilization for Action through Planning and Partnership (MAPP) framework created by the National Association of City and County Officials (NACCHO) to conduct Community Health Assessments (CHA) that inform regular updates of the Community Health Improvement Plans (CHIP). Grounding them in the social determinants of health and a commitment to health equity, these efforts have included extensive outreach with working partners and community collaborators, documented uneven exposure to social and environmental determinants of health, and highlighted resulting health disparities.

To date, planning efforts for environmental health hazards and threats (EHHTs) have been somewhat limited, mainly focusing on water and air quality in public health modernization efforts. However, in the context of a changing environment, residents and businesses will need to adapt to warmer conditions and a more volatile climate. To support residents and businesses, Oregon Health Authority (OHA) has instructed LPHA via Goal 3 of Program Element (PE) #51 of Public Health Modernization to "complete a local or regional climate adaptation plan" by June 30, 2025. This assessment, initiated by the Public Health Division of Marion County Health and Human Services with the cooperation of Polk County, will inform that planning process.

In the context of Marion and Polk Counties, it is clear that LPHA will need to expand their expertise and capacity to protect health during volatile storms, wildfires, longer summers, heatwaves, and more. For example, while the region endured several short but intense heatwaves in the past three summers, the 2021 Pacific Northwest Heatwave, also called the 2021 PNW Heat Dome, has been labeled a 100-year event. Warmer summers have resulted in algae blooms - including a major one in Detroit Lake in 2018 that resulted in high levels of toxins in Salem's drinking water. Several recent summers - including 2020 and 2022 and 2024 - have also been characterized by intense wildfires, threatening homes and shrouding the region in a blanket of smoke. The winter season brings different but no less damaging severe weather conditions with storm patterns threatening a wintery mix and a repeat of the 2021 Ice Storm.

As environmental conditions continue to change, Marion and Polk Counties' residents will face new and more intense EHHTs. The region can expect to continue to see an increased risk of

- wildfires and wildfire smoke;

- longer and hotter summers interspersed with heatwaves;
- droughts and pressure on water quantity (flooding) and quality;
- severe winter storms; and
- increased vectors.

In some instances, threats to infrastructure from these events and conditions may require or result in power outages due to red-flag warnings or extreme events. Each of these are discussed in Section 3 at length, drawing on the latest literature and best practices.

With departments mandated to protect human health, Marion and Polk County must communicate in culturally and linguistically relevant formats about health hazards in real time to reduce exposure and minimize poor health outcomes. Prior preparation - including understanding capacity and communication channels amongst community partners and sister agencies - is critical in improving community resilience for these health hazards.

Health hazards do not impact all populations evenly. Instead, different populations have preexisting vulnerabilities to EHHTs. Vulnerabilities may come about from disproportionate exposures from spatial variation in the hazard or due to daily activities such as outdoor and farm workers being exposed to heat due to the nature of their work. In other cases, certain populations may have a disproportionate risk to the hazard due to underlying health disparities or lack of access to health-promoting resources; this type of disproportionate risk is also often associated with socioeconomic status, linguistic barriers, and lack of trust in governmental information. Finally, some populations may have cumulative risk factors and vulnerabilities with EHHTs amplifying already difficult situations. An example might be the unhoused population at increased risk for wildfire smoke and heat due to their lack of shelter on top of preexisting medical conditions associated with being unhoused.

Thus, a primary goal of this project is to identify which populations are most impacted by each EHHT to align better efforts to protect these populations at greatest risk, also known as vulnerable populations (VPs). We consider the nine categories of vulnerable populations: people from populations with health disparities; those living with an underlying medical condition; those residing in identified fire and flood zones; those with underlying medical conditions; outdoor workers such as construction and farmworkers; frontline workers including firefighters, EMS, and police personnel; those with limited English-language proficiency; low-income individuals; those living without a permanent house; and older adults and children.

To understand the specific needs of our communities, our project combines outreach to community leaders, community partners, and local governmental agencies in the form of 72 interviews with working partners and community collaborators; five focus groups; and a community survey with over 500 responses. Through qualitative and quantitative research methods, we have analyzed these data sources to examine the following research questions:

- **RQ1.** What community and government programs, services, policies, and efforts currently exist in Marion County and Polk County to address vulnerable populations' resilience to environmental health hazards and threats?
- **RQ3.** What local reports, data, and research currently exists highlighting the environmental health hazards and threats that affect residents, visitors, and people employed in Marion County and Polk County?
- **RQ4.** What information has been communicated and is being communicated to vulnerable populations in Marion County and Polk County about environmental health hazards and threats and through what means of communication (such as television, newspaper, radio, social media, organizational communication)?
- **RQ5.** What are the strengths, weaknesses, opportunities, and threats among community and government programs and efforts to address vulnerable populations' resilience to environmental health hazards and threats?

An overview of this analysis is provided in Section 2 below. Many pieces of the analysis also include a separate Appendix to provide more detail.

Part 2: Assessment of Community Needs in Response to EHHT Events

Rationale and EHHT case study overview

Emerging environmental threats are highly contextualized to the local experience. Increasing resilience in Marion and Polk Counties to EHHT events necessitates understanding the threats most likely to occur and which population(s) the threat is most likely to impact. It also requires tracing communication networks and strategies to date. These assessment goals are captured in the following research questions guiding this project:

- **RQ1.** What community and government programs, services, policies, and efforts currently exist in Marion County and Polk County to address vulnerable populations' resilience to environmental health hazards and threats?
- **RQ4.** What information has been communicated and is being communicated to vulnerable populations in Marion County and Polk County about environmental health hazards and threats and through what means of communication (such as television, newspaper, radio, social media, organizational communication)?
- **RQ5.** What are the strengths, weaknesses, opportunities, and threats among community and government programs and efforts to address vulnerable populations' resilience to environmental health hazards and threats?

In addition to general trends of increased heat, more volatile weather, challenging regional wildfire smoke events, and winter storms that often include wintery mix of ice, residents of Marion & Polk Counties have experienced four major EHHT events since 2018 that resulted in emergency declarations:

- 2018 Algal Bloom in Detroit Lake resulted in needing to truck in bottled water for the City of Salem for sensitive groups and pets.
- 2020 Labor Day Fires put life and property at risk in eastern Marion County and resulted in a week-long hazardous air quality event from the smoke throughout the region.
- 2021 Ice Storm destroyed property including trees and power lines, leaving many without transportation options and power for six days or more.
- 2021 Heat Dome that resulted in localized temperature in excess of 115°F.

It is likely that all but the 2018 algal bloom impacting the entire City of Salem water system[1] will be repeated at some level in the near future. Indeed, at the time of writing this report in July 2024, Marion and Polk Counties were experiencing a record breaking, 5-day streak of over 100 degree days.

Investigating how each of these recent events were experienced in the region can help prepare for this new normal. This assessment does so by documenting the challenges of different communities at highest risk while also illuminating the ad hoc strategies that were utilized by individuals, households, and community organizations.

Overview of methods used to assess community needs

To understand the extent of challenges and opportunities of communities in the Marion-Polk region, this assessment utilized the following methods:

1. **Media Scan**: A retrospective analysis of traditional and social media sources was conducted to understand how information was flowing during the four EHHT events.
2. **Community Survey**: A 45-question community survey asking about EHHT perceptions, experiences, and information preferences was piloted in Fall 2023 and widely distributed from April to May 2024. The survey was provided in multiple languages (English, Spanish, Russian) and primarily taken electronically. Nearly 700 attempts at the survey were started, resulting in usable data from 567 respondents. In addition to **analyzing closed-response questions**, open-ended responses were **qualitatively coded and analyzed**. See Appendix A for the Community Survey Instrument.
3. **Community Organization Interviews:** 79 30-45 minute semi-structured interviews were carried out between November 2023 and June 2024. These interviews focused on understanding how community-based organizations served their communities and clients during the four EHHT events. See Appendix B for the Semi Structured Community Collaborators Interview Guide.
    a. Qualitative analysis of transcripts focused on describing the four EHHT events while also asking about strengths, weaknesses, opportunities, and threats (**SWOT analysis**) using a rapid qualitative analysis (RQA) framework.

[1] The City of Salem, after the 2018 Algal Bloom, spent over $80 million to install the state-of-the-art Frank Mauldin Ozone Treatment Facility in 2022 to prevent any further cyanotoxin entering the system. For example, in the Summer 2024, a Harmful Algal Bloom Advisory was issued by OHA for the North Santiam River but did not result in any detectable levels of cyanotoxin after ozone treatment in the Salem public water system.

   b. A **network analysis and mapping exercise** was undertaken to understand how organizations were aware of others' work and communicating with each other.
4. **Community Member Interviews:** Targeted community member interviews were undertaken in several formats. See Appendix C and Appendix D for the Focus Group Guides and Community Member Semi-Structured Interview Guide.
   a. Group interviews (also known as focus groups) were conducted with
      i. Recently resettled refugees (held in Ukrainian and Arabic)
      ii. Farmworkers (held in Spanish)
      iii. Caregivers and advocates of individuals living with intellectual and developmental disability (IDD)
      iv. Older adults
   b. An additional nine semi-structured one-on-one interviews were conducted with community members who represented specific vulnerable populations.

   Transcripts from community interviews were qualitatively coded and analyzed using a rapid qualitative analysis (RQA).

The rapid qualitative analysis (RQA) framework used to analyze the community member interviews and qualitative, open-ended answers to the community survey is a pragmatic approach to "telescope" into lengthy qualitative data. An action-oriented approach well-suited to health research, it combines well-defined semi-structured instruments in anticipation of the need to quickly turn around the analysis. By finding systematic ways to adhere to and elevate the research questions across qualitative data types, a deductive approach to coding participants responses can be quickly indexed into a larger "matrix" of answers. This type of data reduction helps quickly turn around preliminary analysis in a way that might not happen in a more traditional qualitative framework (Hamilton, 2013; St. George et al., 2023). In this assessment, all data collection took place between November 2023 and June 2024 with the analysis for this report completed by July 2024.

Each of these methods and key findings are further described below.

Media Scan

Methods

A media scan was conducted to understand how the four EHHT events were communicated to vulnerable populations, what forms of communication were used, and how communication may be improved in the future. The methods for the media scan were

designed based on the methods of a content analysis. Through a content analysis, researchers can evaluate media to identify communication patterns, look for the presence of key words and concepts, determine the goals of the communication, and assess how communication was received by the public (Mailman School of Public Health, 2016).

The media scan and analysis was divided into five separate tasks.

1. Research background information on the four EHHT events and write summaries of the findings with information about the date and duration of the events, when the event was predicted, and the duration of event impacts.
2. Conduct a social media scan of Facebook, Instagram, Twitter/X, and websites to determine how key organizations in Marion and Polk Counties used social media to communicate during the EHHT events.
3. Review articles from local newspapers that were believed to have reported on the EHHT events, which included the Statesman Journal, The Oregonian, Salem Reporter, and West Side Newspaper.
4. Examine broadcasts from local TV stations that would have provided coverage of the events, including KPTV FOX 12 Salem, KOIN6, and KATU.
5. Write a case study of each EHHT event to compile and summarize the results of the previous tasks, and then use the results to make recommendations for communication during future EHHT events.

The individual case studies were combined to create a full report of the media scan that provides a detailed description of the methods, results, key findings, and future recommendations (See Appendix E for more detailed results). An overview of key findings are provided below.

Key findings and needs

There are several key themes that emerged for communication during the four EHHT events regarding the primary method of communication, the kind of information that was prioritized, availability of additional resources or information, targeted communication towards vulnerable populations, and gaps in communication.

- Social media was the primary method of communication and provided the most information during each of the EHHT events. Facebook was the most popular platform compared to other social media sites. Instagram and Twitter/X had significantly fewer posts and some organizations did not provide any information on those sites. Newspapers and TV stations also communicated about the EHHT events, but coverage varied depending on the event and news source.

- The information being communicated was generally related to human health and safety. Messages regarding health risks and individual actions to mitigate the risk were consistent across platforms. However, health and safety information was not always detailed enough to adequately contextualize the risk and explain how individuals could protect their health.
- Links to additional resources or information to help individuals during an EHHT event were frequently included in social media posts. Newspaper articles and TV broadcasts would sometimes reference other resources or information that viewers could access, but direct links were not typically available.
- Communication frequently mentioned which populations were vulnerable during an EHHT event alongside recommendations for how they could protect their health. However, not all of the populations that may have been vulnerable during a given event received targeted communication.
- Communication may not have been accessible to certain populations as information was often only available in English or posts could not be interpreted by screen readers. This may have prevented non-English speakers or individuals with visual disabilities from accessing critical health and safety information.
- Delayed communication was one of the primary complaints from the general public during the EHHT events. This was a significant issue during the 2018 Algal Bloom because city officials waited several days to make the public aware of the contaminated water supply. The delay caused people to worry about their health and lost trust in the city. Similarly, critical information about the 2020 Wildfires and 2021 Ice Storm was often not shared until the event had already occurred and people were experiencing the impacts.

The results of the media scan revealed various ways that communication may be improved during future EHHT events to ensure that the communication strategies are effective and will reach vulnerable populations.

- Future communication strategies should consider how different demographics access news and incorporate a wider variety of news sources to reach these groups. While social media was the most heavily utilized communication platform during the EHHT events, it is not necessarily the best way to ensure that all target audiences are reached. Older adults are less likely to turn to social media for news, so communication through traditional news sources such as newspapers and TV may be more effective (Liedke & Wang, 2023a). However, social media is still a valuable communication tool as it has become more popular and is widely used by U.S. adults under age 50 (Liedke & Wang, 2023b).

- Communication with vulnerable populations should follow specific guidelines to ensure that communication is accessible and can be easily understood. Communication strategies should be culturally appropriate, utilize the group's preferred communication method, and involve collaboration with trusted community organizations (Florida Vulnerable Populations Communications Work Group, 2009).
- Future communication with vulnerable populations must clearly contextualize the health risks of an EHHT event, describe specific actions for individuals to take, provide additional resources specific to their needs, translate messages into multiple languages, and ensure that digital information and graphics can be interpreted by screen readers (Florida Vulnerable Populations Communications Work Group, 2009).

Perspectives from Residents in Marion and Polk Counties: Community Survey

Methods

The primary purpose of the survey was to have a way for community members to share how their households have been impacted (generally and in terms of health) by EHHTs and to understand their communication preferences. The survey instrument (see Appendix A) included questions on:

1. Perceived impact of and concern about EHHT events and communication preferences (18 questions).
2. Specific experiences with key EHHT events (algal bloom, fires and smoke, ice storm, Heat Dome, drought, or individually identified events) where each event had tailored questions addressing general and health-specific impacts and communication methods (12-14 questions).
3. General demographic information (15 questions).

Questions were a mix of Likert scales (ex. asking respondents how easy it was to find information about an event), multiple choice, select-all (ex. asking respondents to select all categories that apply to someone in their household), and free-response formats (ex. asking respondents what their first source of information about an event was).

This survey was distributed primarily online to community members. The survey was piloted using Google Forms in November 2023. After analyzing responses and gathering feedback from the county, some questions were adjusted and a few questions were

added. In addition to many of the same questions as the pilot surveys, the final version added questions about specific health impacts of EHHTs, as well as event-specific questions about drought conditions and the option for respondents to answer questions about an entirely different EHHT of their choosing.

The final version of the survey was hosted through the survey website Qualtrics. It was distributed via target groups and organizations throughout Marion and Polk Counties from early April to early May 2024. A survey link was available on the Marion County website and was distributed through various public health channels. To capture the experiences of those most vulnerable to EHHT events, we also asked community partners working with these populations to share the survey through their networks. The final version was made available in English, Spanish, and Russian. Paper copies were made available at meetings and events; however, the vast majority chose to take the survey digitally in a web-browser format. Results were analyzed using the statistical computing and data visualization software R, and key findings are presented below. (See Appendix F for more detailed results.)

Characteristics and Demographics of Community Survey Participants

Table 1 summarizes the number of participants for each survey wave. The November 2023 pilots combined resulted in 134 completed surveys; the final Spring 2024 version of the community survey garnered 565 responses, for a total of 699 responses. In order to improve quality, those who did not complete more than 6% of the survey, did not spend at least 5 minutes, and/or showed a CAPTCHA score of less than 70% were excluded, for 567 responses used in analysis.

Table 1 Comparison between pilot waves and final community survey

Survey Wave	**Sampling Method**	**Dates Open**	**Number of Responden**
November 2023 Pilot (Wave 1)	Snowball method, starting in ENVS120	11/14/23 - 12/12/23	110
November 2023 Pilot (Wave 2)	Promoted through the Institute of Continued Learning	11/30/23 - 2/6/24	24
Spring 2024 Final	Posted and dispersed in community	4/9/24 - 5/6/24	565

Despite efforts to seed the survey in Polk County, responses were disproportionately from Marion County. To account for this, all responses were weighted to match actual county populations in 2022. Specifically, responses from Marion county (n=508) had a weight of 682.49, while responses from Polk county (n=59) had a weight of 1,518.88. All summary statistics reported below are weighted accordingly.

The community survey relied on a snowball sampling method and is not representative of the population in terms of gender, race, age, and income. In order to focus on traditionally hard to reach populations, survey distribution targeted community organizations that served populations of interest. Even then, survey respondents were more likely to be between the ages of 18 and 24, female, and white than the general population according to the 2022 American Community Survey (see Table 2). There was also a disproportionately high number of respondents from households with income between $75,000 and $125,000.

Table 2 Comparison of community survey demographics to the actual populations of Marion and Polk Counties

Category	**Demographic Sub-Category**	**Community Survey %**	**ACS % (2022)**
Gender	Female	72.2	50.4
	Male	24.0	49.6
	Other/prefer not to say	3.8	N/A
Race/ Ethnicity	American Indian, Eskimo, or Alaskan Native	0.6	1.7
	Asian	1.4	1.9
	Black	0.4	1.4
	Middle Eastern or North African	0.2	N/A
	Native Hawaiian or Pacific Islander	0.4	1.0
	White	85.3	67.1
	Multiple	8.9	17.1
	Other	2.7	9.8
	Hispanic, Latino*	14.6	26.1

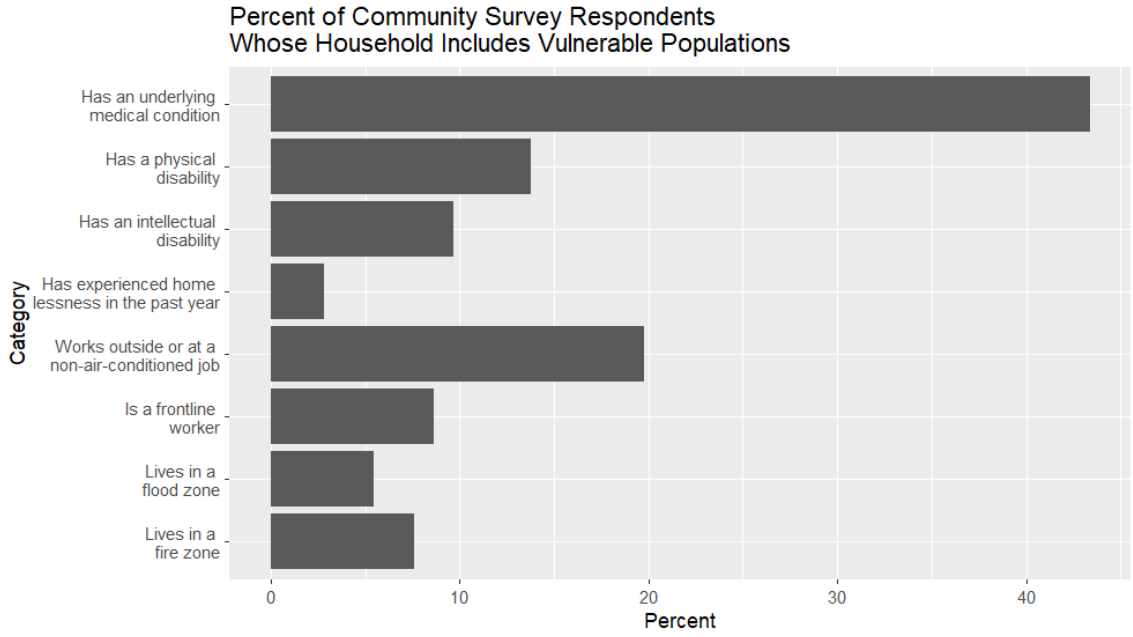
Category	Demographic Sub-Category	Community Survey %	ACS % (2022)
Age	18-24	22.8	12.4
	25-34	12.4	18.1
	35-44	17.7	17.1
	45-54	13.8	15.1
	55-64	12.4	14.6
	65-74	12.4	13.3
	75+	8.6	9.3
Income	$0-$15,000	6.8	7.9
	$15,001-$30,000	10.7	10.5
	$30,001-$45,000	10.7	11.2
	$45,001-$60,000	11.7	11.4
	$60,001-$75,000	7.2	10.5
	$75,001-$120,000**	32.0	26.6
	$120,000+	20.9	21.9

*Hispanic or Latino was treated as its own category separate from the other race options in analysis to mirror how the census collects data.
**The Census and survey income brackets differ; the Census percentage for this category includes those who made $75,001-$125,000.

Some individuals are at higher risk of health challenges to higher risk of exposure and/or biological and social factors. In addition to providing information about the representativeness of the sample, the demographic questions also help describe the vulnerability levels of respondents. Figure 1 shows the proportion of respondents who had a member of their household with a known vulnerability. For example, 20.9% of respondents (n=119) indicated that they were 65 years or older, and 17.5% of respondents (n=67) reported that their total yearly household income was $30,000 or less. Additionally, 8.9% of respondents (n=50) indicated that they do not speak English in their home.

The survey also asked about additional household characteristics that could increase vulnerability to EHHT events: housing status, medical conditions, disability status, job characteristics, and residence within a fire or flood zone. On average, at least one of these characteristics applied to at least one household member for each respondent. For example, 44.1% of respondents indicated that their household included someone with an underlying medical condition, 14.3% included someone with a physical disability, 9.3% included someone with an intellectual disability, 2.5% included someone who had experienced homelessness in the past year, 19.4% included someone who worked outside or at a job that was not in air conditioning at least half of the time, 8.6% included a frontline worker, 6% of respondents lived in a flood zone, and 7.5% of respondents lived in a fire zone.

Figure 1 Proportion of respondents with a household member with vulnerability



Quantitative Findings

This section engages the findings from quantitative questions in the community survey. In general, respondents indicated that their health was less impacted by EHHTs than their overall well-being. This was an expected finding since health is only one subset of the many impacts an EHHT event can have on a household. There was quite a bit of variance in how much respondents reported being impacted by specific EHHTs. Some EHHTs such as wildfire smoke and the 2021 Ice Storm were challenging experiences across the region. Other EHHTs such as direct interaction with the 2020 Labor Day Wildfire or impacts from the 2018 Algal Bloom were experienced by certain subset communities in the region.

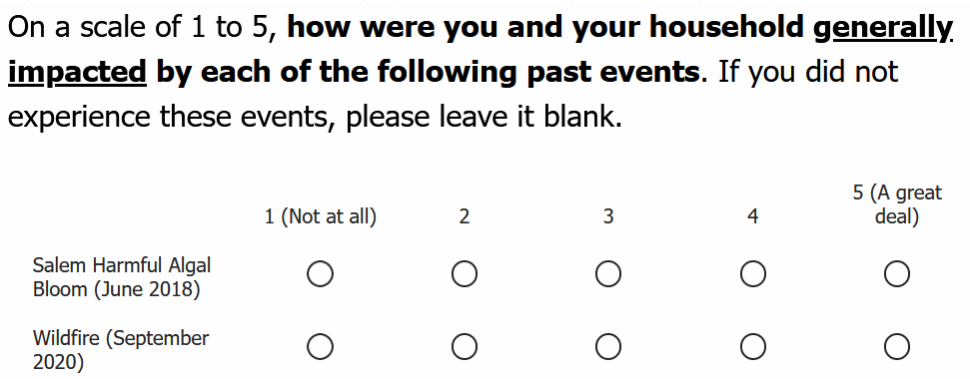
Information preferences of respondents reflect the shift towards internet and smart-phone based sources. There is still a preference for high quality, easy to find, local government sources. Notably, about half of respondents had previously signed to receive emergency alerts from Marion and Polk Counties.

More details about these findings are discussed below.

Impact of Past EHHT Events

Survey respondents were asked to rate how they were impacted by EHHTs on a scale from 1 to 5, with 1 indicating "not at all impacted" and 5 indicating "impacted a great deal" (see Figure 2). A similar question specific to health was also asked.

Figure 2. Screenshot of survey question asking about impact levels



One way to look at the results is to determine what proportion of the respondents selected a 4 or 5, representing a significant deal of impact (see "% rating 4 or 5" in Table 3 and the orange and red in Figure 3). Another way is to look at the mean score columns in Table 3 which can be interpreted as the "average" person's impact. In general, respondents were more likely to perceive a general impact than a health impact to their household across all EHHTs. This likely reflects a perception that health is one very specific type of impact of a difficult event.

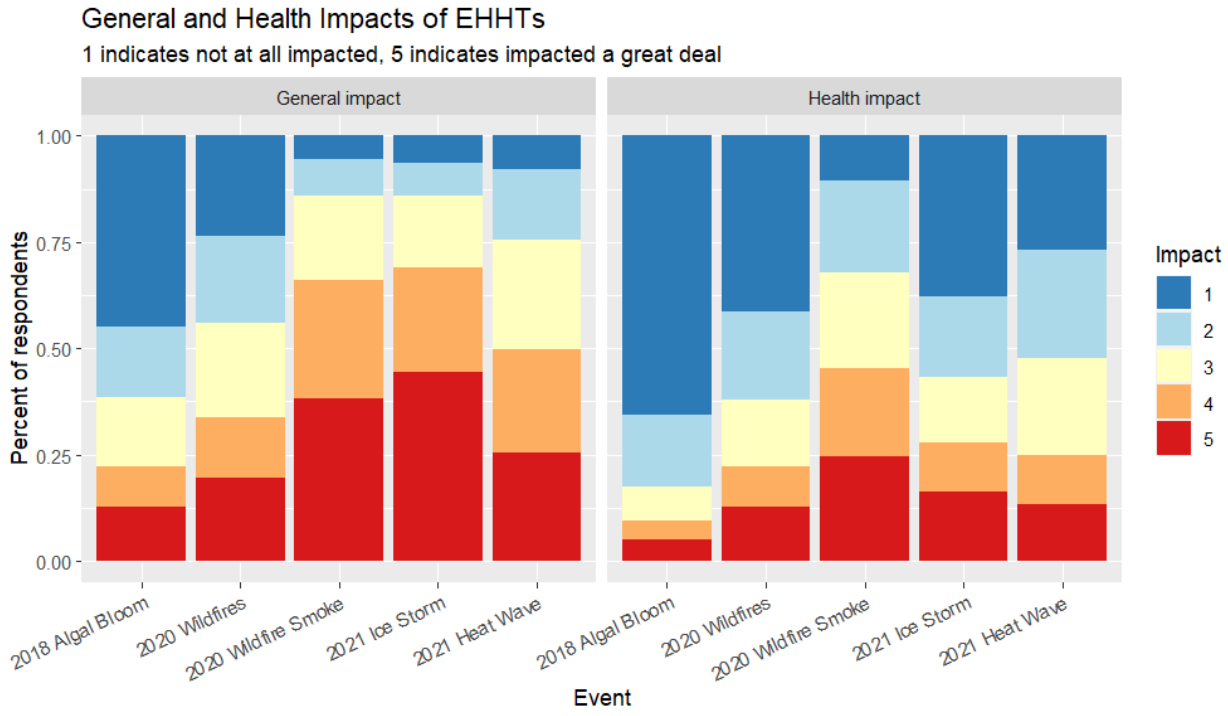
*Table 3. Percent of respondents for each event who indicated that it had an significant impact (responded 4 or 5 on a 5-point scale)**

EHHT	General Impact		Health Impact	
	Mean Score	% rating 4 or 5	Mean Score	% rating 4 or 5

2018 Salem Algal Bloom	2.3	21.5%	1.7	9.0%
2020 Wildfires	2.8	32.7%	2.3	22.2%
2020 Wildfire Smoke	3.9	65.6%	3.3	46.8%
2021 Ice Storm	3.9	67.5%	2.5	27.7%
2021 Heatwave	3.4	47.7%	2.6	25.7%

*Each question asked respondents to consider the general impact (or health impact) of the EHHT event on their household on a scale of 1 to 5 where 1 indicates not at all impacted and 5 indicates impacted a great deal. This table reports on the percentage of respondents choosing 4 or 5.

Figure 3 Distribution of ratings (from 1 to 5) for both general and health impacts by EHHT event



Some patterns emerge when comparing EHHT events to each other. In general, some EHHT events – smoke from the 2020 Wildfires, the 2021 Ice Storm, and the 2021 Heat Dome – impacted the region more generally, resulting in higher mean scores due to fewer people having no impact. Other events seem to have impacted a specific population (very young or immunocompromised for the 2018 Algal Bloom) or area (Salem-Keizer water district for the 2018 Algal Bloom, Santiam canyon for the 2020 Wildfires). For example:

- **2021 Ice Storm**

    - **General Impact:** Respondents indicated that their household was most impacted, in a general sense, by the Ice Storm (mean score of 3.9 with 67.5% choose a 4 or 5). This can be interpreted as the average person selecting a 3.9 on the 1 to 5 scale pictured above and 67.5% selecting a 4 (orange color) or 5 (red color) for general household impact.
    - **Health Impact:** Despite the general overall impact of the Ice Storm, a significant subset did not indicate a health impact using the same scale. The mean health impact score was 2.5 with only 27.7% choosing a 4 or 5 when asked about health impacts. This suggests the health implications of the ice storm are not as obvious to most people affected by the storm.
- **2020 Labor Day Wildfire and Smoke**
    - **General Impact:** Wildfire smoke also highly impacted everyone in the region, tied with the ice storm for the highest mean at 3.9 and about one in three selecting a 4 or 5. A much smaller subset reported being impacted by the wildfires themselves; with a mean impact score of 2.8 and only one in three selecting a 4 or 5. This makes sense because the smoke event was regional while the wildfires were localized to Santiam Canyon.
    - **Health Impact:** More people rated wildfire smoke as having a significant health impact than any other EHHT (mean score of 3.3 with 46.8% rating a 4 or 5); this suggests that respondents are making the connection between hazardous air quality and health. Likely due to the more localized nature of the fire, wildfire mean health impact was 2.3 with only 22.2% rating the health impact as a 4 or 5.
- **2021 PNW Heat Dome**
    - **General Impact:** Despite having regional impact, the heatwave scores were somewhat moderate (mean score of 3.4 with 47.7 percent rating a 4 or 5). A look at the distribution shows the highest proportion of 3 ratings amongst the EHHT events. Some of the moderate ratings may be influenced by personal circumstances in accessing air conditioned spaces.
    - **Health Impact:** The health scores for the heatwave were almost as high as those of the ice storm (mean of 2.6; with 25.7 percent rating a 4 or 5). One explanation for this might be that those who were highly impacted by lack of access to air conditioning felt the physical effects of multiple days of heat and thus are making the heat health connection.
- **2018 Algal Bloom**
    - **General Impact:** The 2018 Detroit Lake Algal Bloom has the lowest mean score of 2.3 and only 21.5% scoring the general impact as a 4 or 5. Looking at the distribution also shows the largest proportion of respondents who were

not impacted at all. This likely reflects the restricted geographical reach of the event and the communication that young children, older adults, and pets were those needing to source alternatives to tap water.

- **Health Impact:** The health impact scores were also low with a mean score of 1.7 and only 9.0% reporting a 4 or 5.

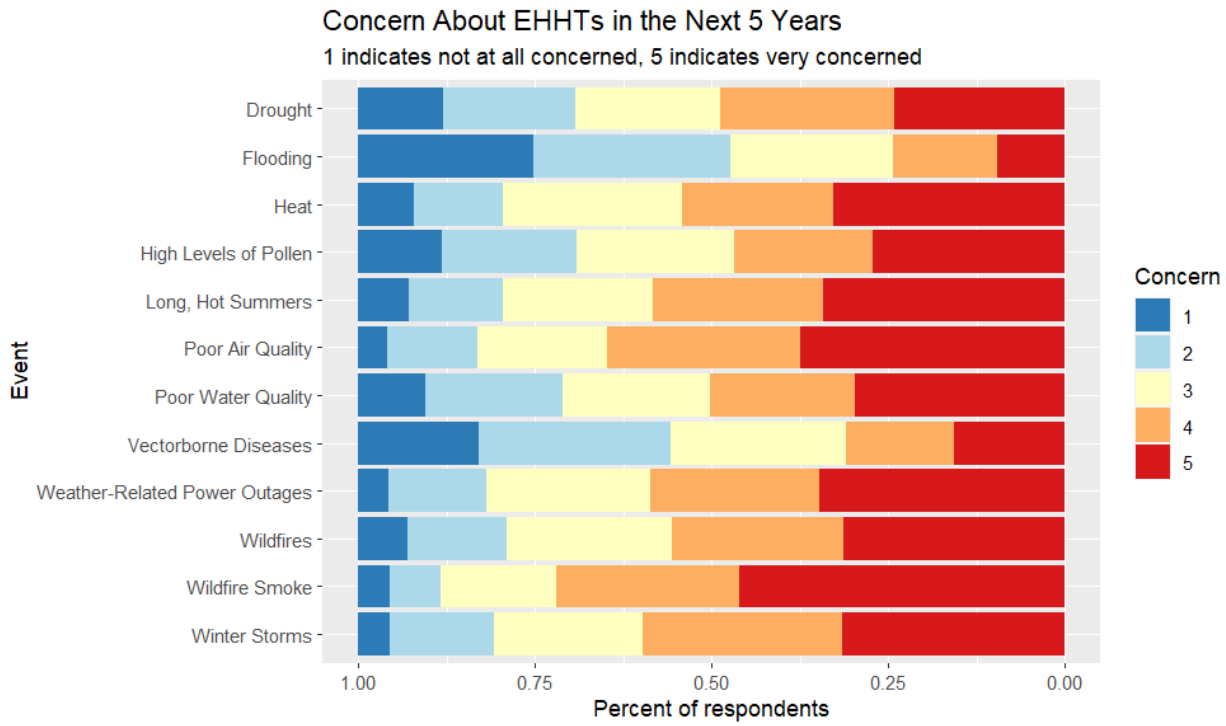
Perceived concern about EHHTs

To gauge public concern about various topics beyond specific EHHT events, all participants were asked to rate their level of concern about 12 issues. Specifically, they were asked if they anticipated the hazard or threat impacting them or their household in the next five years and provided a scale of greatest to least (with 1 indicating "not at all concerned" and 5 indicating "very concerned"). Table 4 displays the mean rating and percent who rated the EHHT as a 4 or 5, sorted from highest to lowest. Table 4 demonstrates the distribution for each EHHT across all ratings with the proportion rating a 4 or 5 in orange and red respectively.

Table 4. Respondents' concern (mean score on 1 to 5; proportion rating 4 or 5) about future (next 5 years) impacts of possible EHHTs

EHHT Concern	Mean Rating	% rating 4 or 5	EHHT Concern	Mean Rating	% rating 4 or 5
Wildfire smoke	4.0	72.4%	Wildfires	3.6	55.3%
Air quality	3.8	65.2%	Poor water quality	3.4	50.0%
Weather-related power outages	3.7	58.0%	High levels of pollen	3.4	48.2%
Severe winter storms	3.7	60.1%	Drought	3.3	48.6%
Long, hot summers	3.7	59.3%	Vector-borne diseases	2.8	24.3%
Heatwaves	3.6	55.0%	Flooding	2.6	30.3%

Figure 4. Distribution of respondents' concern about future (next 5 years) impacts of possible EHHTs



Highlights include:

- Respondents seem to be highly concerned about future wildfire smoke events (mean score of 4.0, with 72.4 percent responding with a 4 or 5 in Table 4). Notably, poor air quality (mean score of 3.8, 65.2 percent responding with a 4 or 5) is of similar concern.
- Respondents remain concerned about weather-related power outages (mean score of 3.7 with 58 percent rating their concern at a 4 or 5), severe winter storms (mean score of 3.7 with 60.1 percent rating their concern as a 4 or 5), long hot summers (mean score of 3.7 with 59.4 percent rating their concern as a 4 or 5), heatwaves (mean score of 3.6 with 55 percent rating their concern as a 4 or 5), and wildfires (mean score of 3.6 with 55.3 percent rating their concern as a 4 or 5).
- Poor water quality (mean score of 3.4 with 50 percent rating their concern as a 4 or 5), high levels of pollen (mean score of 3.4 with 48.2 percent rating their concern as a 4 or 5) and drought (mean score of 3.3 with 48.6 percent rating their concern as a 4 or 5) rated slightly lower and had much more uniform distributions; this may reflect that these conditions typically impact smaller, more specific types of populations.

- Vector borne diseases (mean score of 2.8 with only 24.3 percent rating their concern as a 4 or 5) and flooding (mean score of 2.6 with 30.3 percent rating their concerns as a 4 or 5) were largely not of concern. This suggests a need for educational campaigns, particularly for vector borne diseases which are not typically hyper-local.

Detailed Analysis of Specific EHHT Events

The community survey also provided an opportunity for the respondent to focus on 1-2 past EHHT events. By grounding questions in specific events, survey respondents are sometimes able to give more accurate and pertinent information. Care should be taken when interpreting answers however, because there will be some selection bias.
Table 5 below shows how many community members chose each of the EHHTs to provide more in-depth information. Most people chose to answer questions about the 2021 Ice Storm (37.4 percent) or the wildfire smoke (32.6 percent) from the 2020 Labor Day fires. A far smaller percentage chose to engage in the other EHHTs sections.

Table 5. Number of respondents who answered EHHT-specific questions

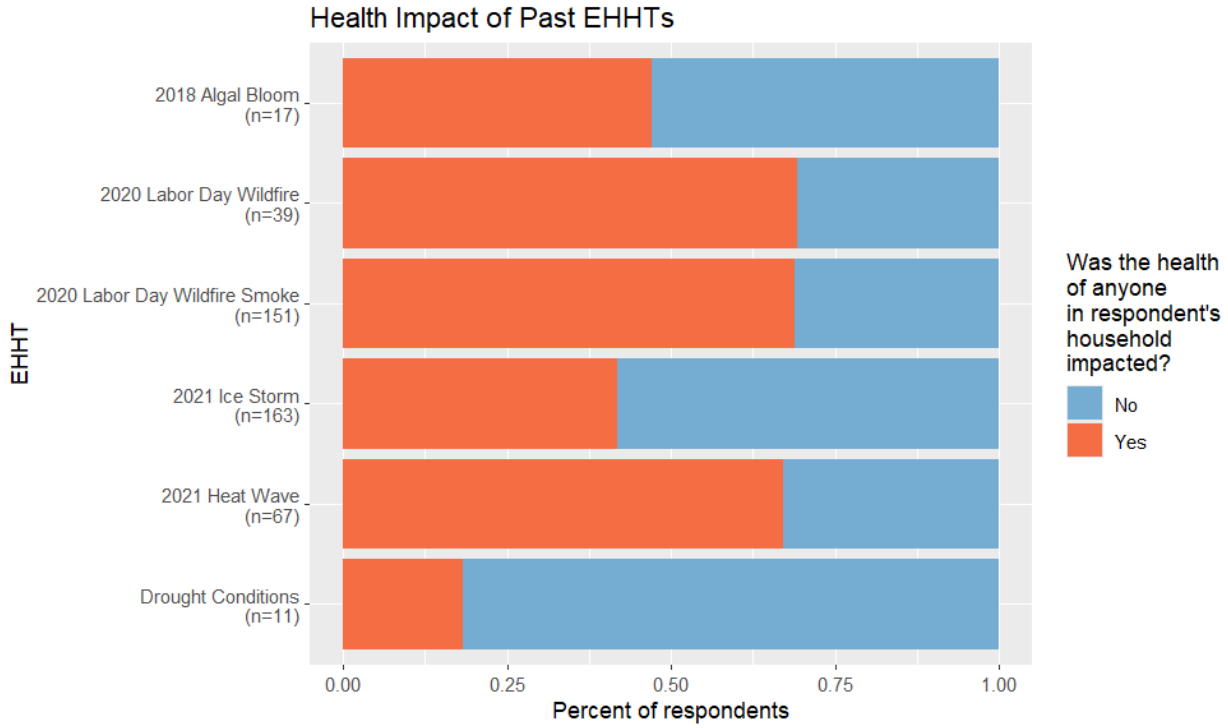
EHHT	n	% of total sample*	Mean Rating for seriousness of EHHT	% of respondents who said their health was impacted
2018 Salem Algal Bloom	27	4.7	3.4	43.9
2020 Wildfires	53	9.4	4.0	69.0
2020 Wildfire Smoke	185	32.6	3.9	68.8
2021 Ice Storm	212	37.4	3.8	42.2
2021 Heatwave	79	13.9	4.0	68.5
Drought	11	1.9	3.2	22.0
Respondent's choice	16	2.8	–	–

*Percentages will not add up to 100 because respondents had the option to answer questions about two different events; additionally, not every respondent chose to answer EHHT-specific questions.

Within each EHHT section, respondents were asked the question "In your view, how serious a problem was the [event] for your household?"; answers were converted into a Likert scale with 1 indicating "Not a serious problem" and 5 indicating an "Extremely serious problem". The mean response is also provided in

Table 5. Those responding to the 2020 Wildfires (n=53) and the 2021 Heatwave (n=79) reported the highest average responses, with a mean of 4.0 for each event and over two-thirds saying their health was impacted. The smoke from the 2020 Wildfire and the 2021 Ice Storm were also on average rated as very serious by those who chose to share about them, with mean ratings of seriousness of 3.9 (n=185) and 3.8 (n=212), respectively. Again, over two thirds sharing about the 2021 Heatwave reported their health was impacted; however only 42.2 percent of those sharing about the 2021 Ice Storm believed their health was impacted. On the other hand, the 2018 Algal Bloom (mean=3.4, n=27) and drought conditions (3.2, n=11) were rated lower.

Figure 5. Extent to which a respondent or someone in their household's health for each EHHT section



Respondents generally perceived a lower impact on health than logistics at large. The event-specific modules included a yes or no question about whether the chosen event either directly or indirectly impacted the health of anybody in the respondent's household. The responses clustered into three groups Figure 5:

- EHHTs that are perceived to have impacted health included the 2020 Wildfire (69.0%) smoke from the 2020 Wildfire (68.8%) and the 2021 Heatwave (68.5%).

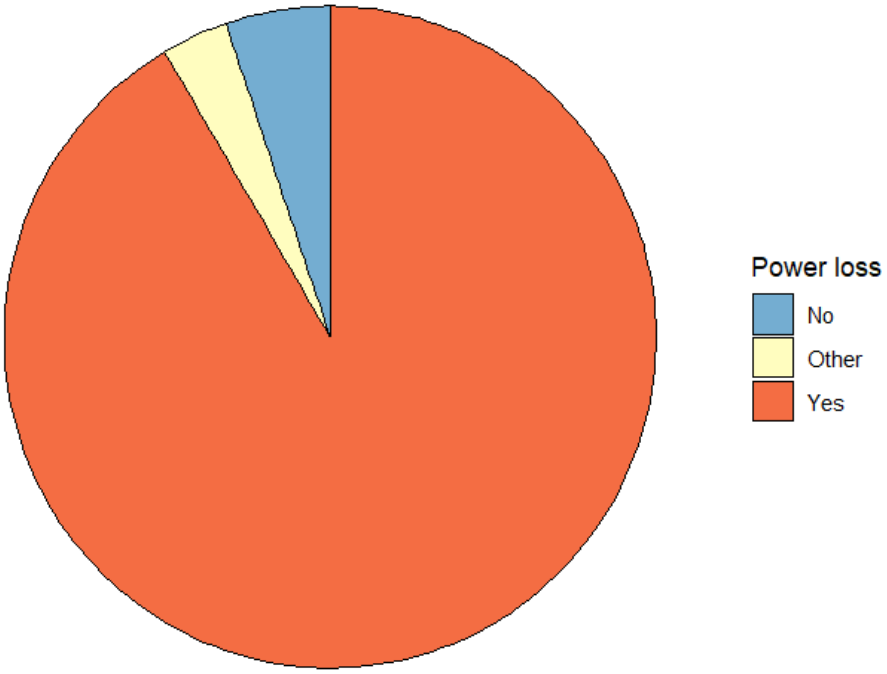
- EHHTs that were perceived to be a logistical concern rather than health concern included the 2018 Algal Bloom (43.9%) and 2021 Ice Storm (42.2%).
- EHHTs where connections between the environment, household logistics, and health are not clear included drought conditions (22%) and other environmental conditions of the respondents' choosing.

Vulnerabilities and actions were also assessed by EHHT as discussed below.

Ice Storm

A good overview of the 2021 Ice Storm can be found on Oregon's Office of Emergency Management's 2021 February Winter Storm Spotlight. Those who answered questions about the 2021 Ice Storm were asked if their household lost power during the storm, to which 92.1% (n=194) of respondents answered "Yes". Only 5.3% (n=11) of respondents' households did not lose power.

Figure 6. Respondents of ice-storm section who indicated loss of power during 2021 storm



Wildfire Smoke

Respondents who chose to answer questions about the smoke from the 2020 Wildfires were asked about health conditions and working conditions that might make them more vulnerable to the smoke (Table 6). The answers make it clear that those who answered this section included many people with significant pre-existing conditions or biological risk.

- Preexisting respiratory conditions: 47.0% (n=87) of respondents in this EHHT section indicated that somebody in their household had asthma, 7.0% (n=13) reported that somebody had COPD, and 23.2% (n=43) responded that somebody had another respiratory condition.
- Preexisting cardiovascular conditions: 33.0% (n=61) of respondents who engaged the wildfire smoke section reported that somebody had high blood pressure, and 7.6% (n=14) responded that someone had another cardiovascular condition.
- Additionally, 16.4% (n=28) of respondents to these questions were age 65 or older.

When asked if anybody in their household worked outside in September of 2020, 44.1% (n=82) of respondents answered affirmatively.

Table 6. Respondent-reported risk factors in household for health complications from smoke from the 2020 Wildfires

Risk factor	n	% of respondents
Age is 65+ or older	28	16.4
Respiratory - asthma	87	47.0
Respiratory - COPD	13	7.0
Respiratory - other	43	23.0
Cardiovascular - hypertension	61	33.0
Cardiovascular - other	14	7.6
Household member worked outdoors	82	44.1
Lived outdoors	8	3.8

Wildfires

Respondents who answered questions about the 2020 Labor Day Wildfires were asked several more specific questions about how the fires impacted them, including several about evacuation which were accompanied by the classic "Ready. Set. Go." graphic.

Figure 7. Evacuation levels for wildfire

Those who engaged this section were highly impacted by the fires. Nearly 30 percent (n=14) of respondents in this section indicated that they lost property or pets to the wildfires. Almost half (47 percent, n=24) reported that their household lost power due to red flag conditions. The vast majority (79.6 percent) received some type of evacuation warning and 44.6% evacuated at some point (Table 7).

- 20.8% (n=11) received a Level 1 warning, and one household evacuated at that point.
- 27.9% (n=14) received a Level 2 warning, and 57.1% of those households evacuated.
- 30.9% (n=17) received a Level 3 warning, and 76.5% of those households evacuated.

Table 7. Evacuation warnings received by those who engaged the 2020 wildfire section

	Number of households reporting		% of households reporting	
Warning level	**Highest level warning was at this level**	**Evacuated at this level**	**Highest level warning was at this level**	**Evacuated at this level**
Level 1	11	1	20.8%	1.7%
Level 2	14	12	27.9%	22.5%

Level 3	17	12	30.9%	20.4%
Don't remember/didn't receive a warning/didn't evacuate	5	22	8.5%	39.4%
Other	7	7	11.9%	16.0%

Extreme Heat (2021 PNW Heat Dome)

Those who chose to respond to the 2021 Heat Dome section were asked about risk factors for prolonged exposure to extreme heat. For example, respondents were asked about access to air conditioned spaces for work or school:

- Less than half (36.7%, n=29) of respondents reported that they worked or went to school somewhere with air conditioning during the day.
- Of those who answered questions about other household members, about half (48.5%, n=16) indicated that another person in their household did not have access to air conditioning during the day.
- Of the 5 people who chose an option concerning their child(ren), 4 (80%) reported that their kids' schools or daycare had air conditioning.

Respondents were also asked about their household air conditioning systems, both in 2021 and currently. In general, there has been widespread adoption of air conditioning after the 2021 Heat Dome (Table 8 and Figure 8). When asked about the 2021 PNW Heatwave or Heat Dome, 32% (n=26) did not have any type of home air conditioning at that time; today, that is closer to 18.1% (n=15).The percentage of respondents who had access to air conditioning of some form increased in all categories: more people have whole-home systems (35.6%, n=27), air conditioning in some but not all rooms (14.2%, n=10), and a window or portable unit (29.1%, n=22) than in 2021 (31.7%, n=22; 7.3%, n=7; and 24.7%, n=19, respectively).

Figure 8. Responses about access to air conditioning during the day for those engaging the 2021 Heat Dome Section

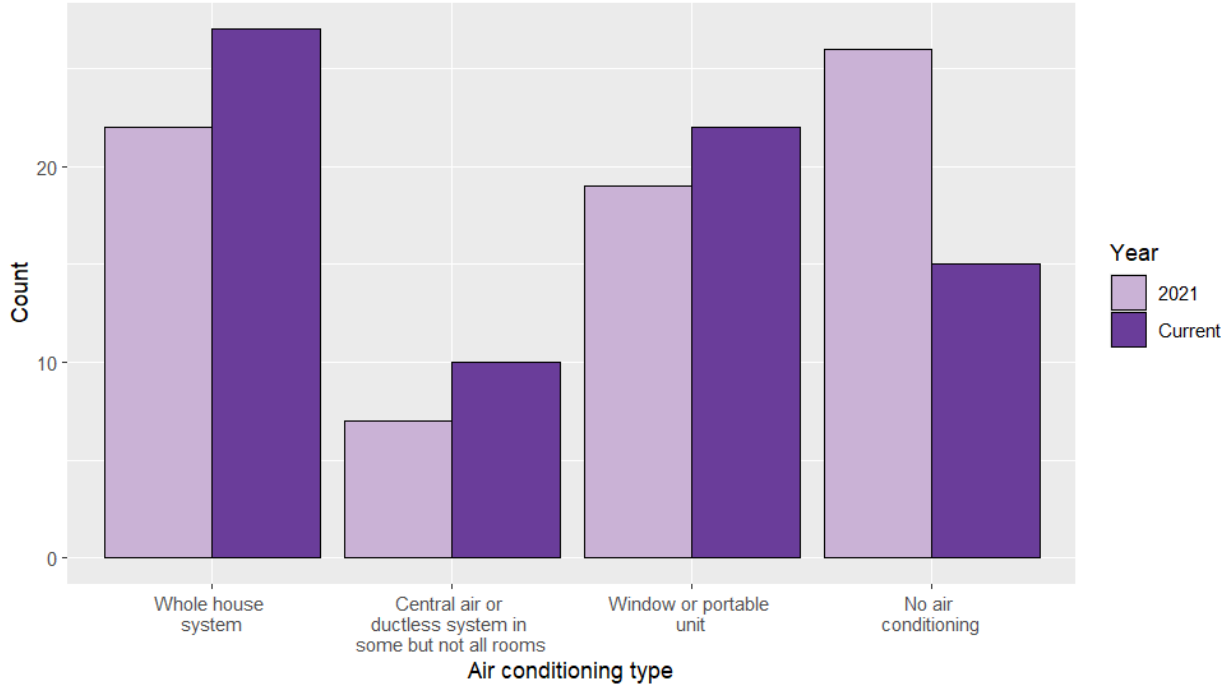


Table 8. Responses about access to air conditioning during the day for those engaging the 2021 Heat Dome Section

Daytime AC access	**n**	**% of respondents***
Respondent worked or went to school somewhere with AC	29	36.7
Someone else in the respondent's household worked somewhere with AC	17	21.5
The school or daycare the respondent's child(ren) attended had AC	4	5.1
The respondent was working outdoors without AC	14	17.7
Someone else in the respondent's household was working outdoors	11	13.9
The respondent was working in a building without AC	10	12.7
Someone else in the respondent's household was working in a building without AC	5	6.3

The respondent's child(ren) did not have AC at their school or daycare	1	1.3

*Percentages don't add up to 100 because respondents could choose multiple options when answering this question.

One way to check the representativeness of those who answered the heat section is to compare these to the US Census' American Housing Survey. This comparison is provided in Table 9. A higher percentage of Salem residents answering the survey reported not having primary air conditioning in their homes than those in the Portland metro area in 2019 (21.4%). Additionally, of the respondents whose homes had central or room-specific air conditioning in 2021, more had central or whole-house systems (75.9% compared to 62.8%), while fewer had room-specific systems (24.1% compared to 37.2%) than units in the Portland area. However, the American Housing Survey did not collect data about window or portable air conditioning, which made up nearly 40% of survey respondents' air conditioning systems in 2021.

Table 9. Access to home air conditioning in this assessment's survey versus the 2019 American Housing Survey for the Portland, Oregon region

Air conditioning type	**% of Portland metro area housing units with this type (2019)**	**% of survey respondents with this type (2021)**	**% of survey respondents with this type (2024)**
Whole-home or central system	49.3%	31.7%	35.6%
Some but not all rooms	29.3%	7.2%	14.2%
Window or portable air conditioner	N/A	24.7%	29.1%
No air conditioning	21.4%	32.0%	18.1%
Other	N/A	4.4%	3.1%

Algal Bloom

Only 27 people opted into the 2018 Algal Bloom section; each was asked if their households included any vulnerable populations at the time of the Algal Bloom. As expected, a large proportion (59.3%, n=16) of respondents who were concerned about the

Algal Bloom indicated that their household included someone who fell into at least one of the following categories:

- *Life course vulnerabilities* included children under the age of 6 (14.2%, n=4), older adults over the age of 65 (31.9%, n=9), and pregnant or nursing people (3.5%, n=1) .
- *Preexisting conditions* included immunocompromised people (15%, n=3), but no one with someone on dialysis in their home at the time of the bloom opted into this EHHT section.
- *Pets* (28.3%, n=8).

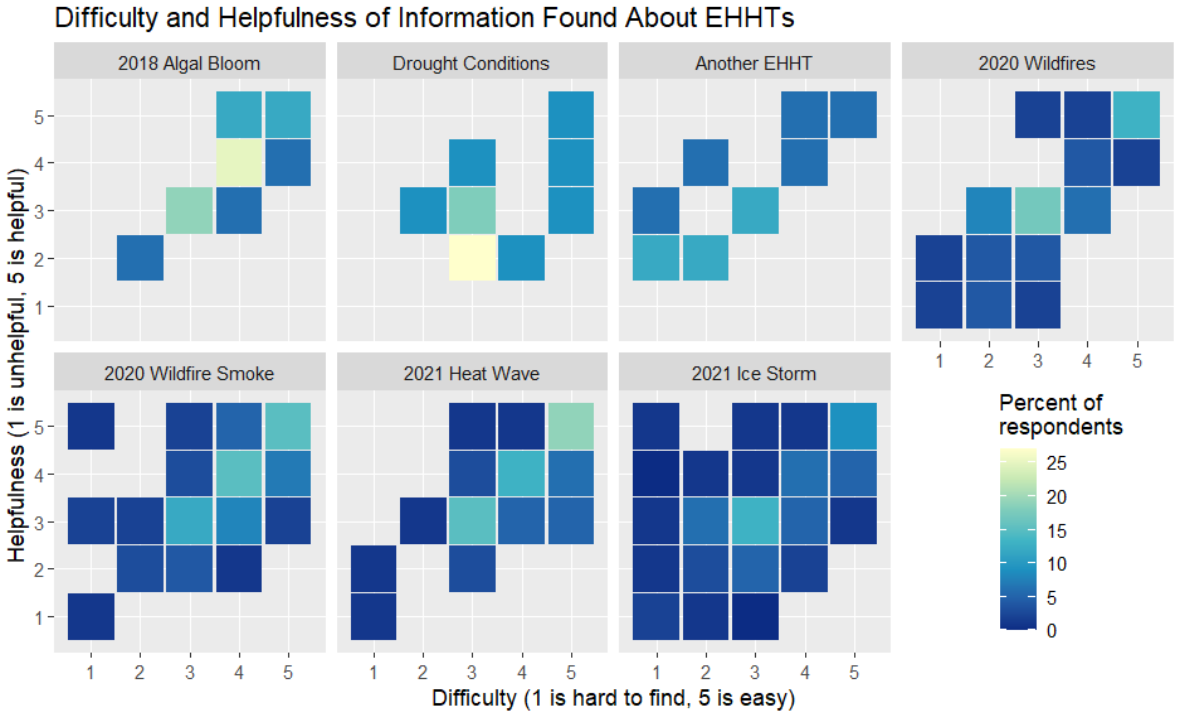
Respondents were also asked how they sourced water during this time; roughly half of those who answered this question reported that they bought bottled water (50.3%, n=13), a quarter reported that they relied on free water from community distribution centers (25.6%, n=6), 10.6% (n=3) transported water from outside the affected area, and 15% (n=3) chose an "other" option.

Information Sources for EHHTs

Each respondent who answered event-specific questions was also asked how easy it was to find information and how helpful that information was. In general, there was a correlation between ease of finding information and its helpfulness, as seen in Figure 9 below. Both questions were asked on a 1 to 5 scale with 1 being hard/unhelpful and 5 being easy/helpful. Highlights include:

- The average score for ease in finding information was positive (above 2.5) for all EHHTs.
- The 2021 Heatwave was the easiest EHHT to find information about (mean=4.0), followed by the smoke from the 2020 Wildfires (3.9), drought conditions (3.7), the 2018 Salem Algal Bloom (3.5), the 2020 Wildfires themselves (3.4), and the 2021 Ice Storm (3.3).
- Respondents who told us about another event of their choosing reported that information about that event was generally more difficult to find than information about listed events, with a mean difficulty rating of 2.6 (n=14).
- Similarly, the order in which respondents rated ease of finding information tracked to the helpfulness of information found. The correlation between difficulty and helpfulness of information suggests that generally, information which is more accessible to the public may also be easier to understand.

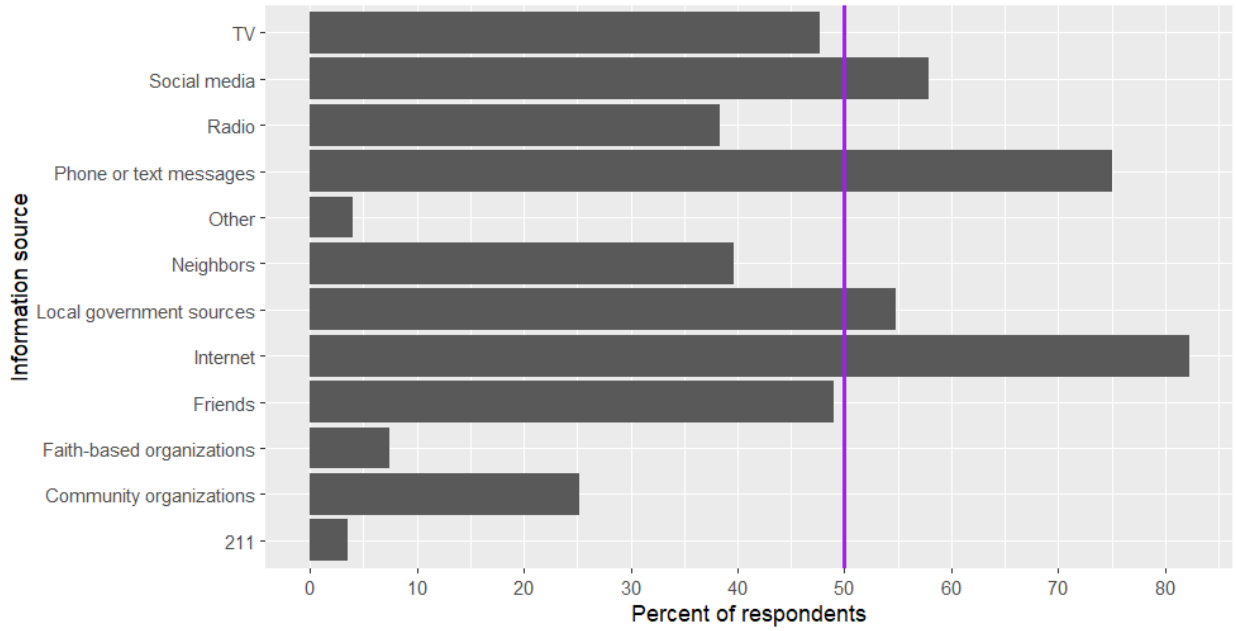
Figure 9. Correlation between ease of accessing information and helpfulness of information by EHHT



All respondents were asked about the Emergency Alert System. Nearly half of respondents (48.8%, n=267) reported that they had previously signed up for the Marion and Polk County Emergency Alert System, while around 28% (n=162) indicated that they had not signed up to receive alerts, and 22.1% (n=128) of respondents were not sure if they had signed up or not.

Figure 10 shows which information sources respondents would turn to in a future EHHT. A majority of respondents indicated that during a future EHHT, they would use one or more of the following news sources: the internet (81.6%, n=467), social media (58.2%, n=329), phone or text messages (75.2%, n=426), and local government sources (55.6%, n=311). When asked what source of information they would turn to first, the largest share of respondents chose the internet (38.4%, n=217), which was followed by local government sources (15.3%, n=84), phone or text messages (14.9%, n=83), then social media (11.1%, n=57).

Figure 10. Information sources survey respondents would turn to in a future EHHT



Responses to the open-ended portion of this question (n=19) suggested alternate apps and alert systems, which included FlashAlert, Marion County Alerts, Pulsepoint, Newsbreak, 911 alerts, WU Alerts, the Watch Duty App, Everbridge, and Red Cross Alerts. Other sources discussed included family (n=5), the workplace (n=5), via email (n=3), and via schools (n=3), which included Englewood Elementary, Roberts Middle School, and Chemeketa Community College. Three respondents described personal barriers to receiving information such as not having a cell phone to receive alerts, relying on email alerts because they cannot text, and inability to receive information during the Ice Storm due to the power outage.

Qualitative Findings

Each of the EHHT-specific sections also included open-ended prompts for respondents to share the impact to their household, their household's health, and information specific. Most responses were a single sentence; however, some ran several paragraphs long. These responses were inductively coded (SEE APPENDIX FOR FULL SUMMARY TABLES) and are summarized below by EHHT.

Ice Storm (n=172)

The 2021 Ice Storm was clearly one of the most impactful EHHT events with 172 survey respondents choosing to discuss it. The most common topics discussed in the open-ended responses included power loss, health impacts, damage done to homes and the landscape, and dangerous conditions.

For example, power loss was mentioned 212 times throughout the free responses. Through these comments, it was clear that loss of power impacted heating, cooking, refrigeration, well water, sump pumps, and refrigerated medicines. It also inhibited people from accessing information, doing work, and school activities since many schools were online at the time. Most respondents said they had lost power for around a week. A few said over two weeks or less than a day.

Consistent with the quantitative responses, respondents focused more on damage (n=40) to property and landscape including fallen trees and branches which damaged houses, cars, and power lines and blocked roads. Many (n=31) discussed evacuation decisions during this time in order to have power. In this context or in the context of travel to work, doctors appointments, and to get food, respondents (n=20) discussed dangerous road conditions. Numerous respondents (n=65) discussed the economic challenges from repairs, evacuating, and replacing food and medicines that may have spoiled.

Physical health impacts were discussed (n=35) almost as much as property damage. Descriptions of physical health impacts included frostbite, illnesses which may have worsened preexisting conditions, loss of mobility, and lack of sleep. Vulnerable populations mentioned included older adults (n=8), children & babies (n=8), and people with preexisting conditions (n=6). People with preexisting conditions were impacted if their condition worsened from the cold, their medicine spoiled, or if they couldn't use technology to alleviate their condition.

Mental health impacts were discussed (n=15) and centered around stress, anxiety, and previous trauma. For example, one respondent shared how

> *"All of our mental health still suffers from the night the majority of the limbs dropped. We were cold (yet had enough clothing and blankets), exhausted (yet couldn't sleep from the sound of limbs crashing onto our home), scared (all 4 were terrified one of the falling limbs would crash through our roof. Even the smallest of limbs sounded like a gunshot."*

Another described how *"the stress of maintaining heat and refrigerators/freezers in the home was extremely high. Also, stress was increased due to fear of water pipes bursting from freezing."*

The most widely used source of information during the ice storm was the internet & social media. Over half of respondents (n=108) shared comments that suggested they were

relying on websites and social media for information, although only a few of these specified what platforms or websites they went to. News sources were mentioned fifty-four times, with sources including the Statesman Journal, the National Weather Service, and the Weather Channel. Government sources were mentioned twenty-nine times, and they included local city and county websites, Flashalert, and 211. Other sources of information included personal relationships such as friends, family, and neighbors (n=85), radio (n=29), PGE (n=25), Trip Check (n=2), and the weather app (n=1). Many reported difficulty with finding information (n=45); the two most discussed challenges included how the loss of power reduced the ability to access the internet and how the PGE call line was overwhelmed.

Wildfire Smoke (n=157)

After the 2021 Ice Storm, wildfire smoke was chosen as the most impactful EHHT event that people wanted to discuss. Similar to the quantitative findings, respondents were more likely to link the event (smoke) to health than any other EHHT. Almost all respondents (n=142) discussed physical symptoms such as difficulty breathing, coughing, burning eyes, irritated throats, lightheadedness, congestion, worsening of preexisting conditions like asthma, and sleep loss. Many (n=23) also discussed the mental health impacts of the event, which included stress, anxiety, and fear. Populations at greater risk of the smoke included people with preexisting conditions (n=35), outdoor workers (n=12), children & babies (n=8), older adults (n=7), frontline workers (n=1), and pets & livestock (n=24). The most common preexisting condition shared in the comments was asthma; other comments included COPD, sleep apnea, diabetes, chronic migraines, emphysema, cardiovascular issues, and unspecified respiratory diseases.

One theme was respondents (n=27) sharing the difficulties of keeping smoke out of their homes, often framed as needing to do so to reduce risk to health and damage to belongings. Several (n=10) discussed the economic challenges associated with smoke damages including: paying for or repairing AC systems and air purifiers, paying for supplies, and paying for replacing items that were covered in ash. For example, a respondent described how they had

> *"financial difficulties after the price gouging that we encountered on the air purifier we had to purchase in order to help my elderly mother with the air so that she would be able to breathe better."*

Over a third of respondents (n=65) discussed how they were unable to leave the house due to health concerns, impacting ability to work, exercise, or take care of pets. Another issue that was discussed was concurrent high temperatures (n=9) and how people without AC

were unable to cool off by opening windows, and the high temperatures caused sleep loss for some.

Respondents (n=20) also discussed smoke as a barrier or catalyst during fire evacuation. Some shared difficulties such as visibility issues. Others shared wanting to evacuate to seek cleaner air with some disclosing there was nowhere to go. In many cases, the travel itself was a hardship and offered very little relief given how much of the west coast was engulfed in smoke. For example, one respondent in the latter group described how

> *"it was so bad I took my mother to Montana. The air quality was so bad in California, Washington, Idaho, Canada, and Montana that we returned home to Oregon. Leaving Oregon didn't give us any relief."*

The good news is that only four respondents discussed difficulty getting information. The most common source of information (n=110) discussed was the internet and social media. While most did not give specifics, some did share reliance on public or private Facebook groups and X/Twitter. More traditional news sources (n=78) were generally discussed; a few included specifics such as the Statesman Journal, Univision Portland, and the Weather Channel. About one in five turned to government sources (n=30), identifying local county and city websites, Marion County Emergency Management, Inciweb, and more. Respondents were slightly more likely to mention personal relationships (n=41) like friends, family, neighbors, and work as information sources. Radio (n=9) and various weather apps (n=15) such as the Weather App, Accuweather, and OregonAir were also mentioned.

Wildfires (n=43)

The 2020 Labor Day Fires (or 2020 Wildfires) were a devastating event that had a deep emotional and mental impact on those who lost homes, lost friends and loved ones, or had to evacuate. When compared to wildfire smoke, those who chose to share about the 2020 Wildfires were more likely to discuss impacts to mental health. More than half of the respondents (n=22) reported mental health impacts including depression, anxiety, stress, and PTSD. For example, one respondent discussed that while they weren't physically impacted, *"I've suffered from deep depression off & on since losing my dream house in the fire in Gates and having to start over in Independence with a fixer upper house."* Another said

> *"The stress was terrible about what our plan would be if we were to have to move if [the fires] got much closer to us, as well as the stress and worry about all other family and loved ones that I couldn't get ahold of. Everything was terrifying. A family*

friend up by Opal Creek burned to his demise in the fires along with his dogs and home and shop and everything he had worked so hard to build up his whole life. It was all so sad and scary."

Over three-quarters (n=34) discussed evacuation during the fires. Some (n=15) estimated how long they had evacuated with a bimodal distribution of three to seven days to several weeks. Some of the issues with evacuating included the mental health impact on the respondents and their families, receiving the incorrect evacuation alert, the difficulty of transporting pets and livestock, and an unavailability of hotels.

Other household impacts included the damage of homes or nearby landscapes (n=19), often mentioning the emotional impact. Ten respondents mentioned losing power, but very few gave timeframes for this. Seven respondents discussed being unable to do work or other activities during this time frame as well.

Fewer respondents (n=15) discussed physical health issues. Those that did tended to focus on respiratory challenges (also discussed in depth in the wildfire smoke section) and worsening of preexisting health conditions. The vulnerable populations mentioned by respondents, frontline workers (n=3), people with preexisting conditions (n=2), children & babies (n=1), and older adults (n=1). Caring for and evacuating pets & livestock (n=7) during these events was challenging to the household logistics, mental health, and the animals.

There was no uniform source of information preferred among respondents. Government sources were mentioned twenty times, and they include emergency alerts, Inciweb, Metcom, Marion County Emergency Management, wildfire trackers, evacuation websites, and other local government sources. Other sources of information included personal relationships like friends, family, neighbors, and their workplace (n=23). Internet and social media (n=26), news sources (n=14), and the radio (n=2) were also highlighted. Several respondents (n=7) discussed issues with not receiving alerts or receiving the incorrect alerts.

Heat (n=68)

Heatwaves in general, and the 2021 PNW Heat Dome in particular, were discussed in depth by 68 respondents. There were 34 mentions of AC challenges. About one third (n=26) discussed lacking AC at home or in their workplace and twelve respondents discussed the cost burden of AC. Low-income individuals and renters shared particularly poignant information about the difficulty of installing and affording AC. For example, one shared

> *"As a renter without access to an AC unit, the ability to stay cool and regulated and safe during that time was impossible. I had to leave the area and stay with family who were in cooler environments. Renters, along with homeowners, matter in these sorts of surveys. I hope they are being considered as well. Many of the apartments and home rentals in this area are without air conditioning units or effective heat/ air flow with no incentive from the landlord to make those needed changes."*

Fewer people had direct experience as an unhoused individual, an outdoor worker, or a frontline worker. However, those who did mentioned the difficulty of doing normal outside activities and the impact on health, employment, and wellbeing:

> *"We could not do any manual labor outside, especially related to farm work. Crops were damaged significantly, impacting many individuals' livelihood, and the state government response to concerns was silent and reaffirmed to many farmland landowners that the government doesn't care about the smaller agricultural business owners, especially immigrant Russian owned farms."*

Other hardships included stress around caring for pets (n=11), failing appliances (n=10), and inability to do normal activities (n=8). There were ten mentions of the difficulty of caring for gardens. Several people discussed fear of a power outage from an overloaded grid (n=5) including one who was fearful they would lose access to oxygen for their COPD.

Almost half of the respondents discussed physical health impacts (n=29) including trouble sleeping, headaches, dehydration, shortness of breath, nausea and vomiting, fever, heat exhaustion, heat stroke, and passing out. At least seven respondents connected the heat to mental health challenges. Some specifically mentioned challenges of preexisting conditions (n=12) including challenges regulating body temperature; controlling chronic conditions such as asthma, diabetes and cardiovascular disease; and the worsening of ADHD and autism. Several respondents (n=4) who were expecting children at the time discussed concern about their unborn children with one sharing an experience about preterm birth.

Algal Bloom (n=17)

Open-ended responses from the 17 individuals who chose to share about the 2018 Algal Bloom focused primarily on the difficulty of sourcing water and what those alternative solutions were. This included financial and time hardships of sourcing water. Mentions of vulnerability focused on children, babies, and pregnant women with the occasional mention of preexisting conditions.

Many individuals sought local government information and were frustrated with inconsistent messaging in the response, often resulting in mental health impacts and eroded trust in government. For example, one respondent said that while they were not physically impacted,

> *"our emotional wellbeing was another story. Our places of work and kids' school were constantly getting mixed messages about which water sources were safe to drink at which times and we were scared unnecessarily multiple times."*

Another stated

> *"We were so worried after knowing that we were giving perhaps compromised water all weekend to a young baby. The city should have known earlier and let the info out. We understand that things happen, but when not notified, it still makes me mad. It makes trust in the government erode."*

Drought (n=11)

Eleven individuals chose to engage in drought as an EHHT. The open-ended responses from these individuals discussed both human health impacts (asthma, dehydration) and environmental impacts (exacerbating wildfires, impacts on plants and animals). There was no mention of local government resources as information. Instead, respondents are leveraging TV, internet news, and social media. A few are seeking information from friends or community resources like a school or food bank.

Key Findings and Needs From Community Survey

Several key findings and cross cutting themes emerged from the community survey.

First, the vast majority of households (66.2%) reported some sort of increased risk or vulnerability for someone in their household. However, these individual and household risks do vary by EHHT. This suggests:

- Communications should be fairly broad for EHHT events because many households are potentially impacted.
- The communication itself, however, should inform the public of individual and household risks and vulnerabilities.

The 2021 Ice Storm, the smoke from the 2020 Wildfires, and the 2021 Heat Dome highly impacted the region; however, residents are more likely to associate poor health with wildfire smoke, and to a lesser extent heat, than severe winter storms or ice storms. Most

respondents, regardless of EHHT, focused on describing household logistical and economic impacts more than health impacts. However, many described challenges to basic conditions and social determinants of health such as work, food, or medicine loss. This suggests:

- Public health should consider upstream, social determinants of health in preparing for and managing EHHTs.
- Educational campaigns about the explicit link between each EHHT and health are needed to help individuals better prepare for and prevent illness and injuries during the event. This is particularly true for heatwaves, ice storms, algal blooms, and drought.

Mental health challenges including worry, stress, and trauma are often associated with EHHT events.

- While EHHTs are inherently stressful, lack of preparation magnifies the sense of stress during the event.
- Mental health challenges are evident long after the EHHT resolves. Community resilience strategies should include increased resources specifically for mental and emotional well-being for months and sometimes years afterwards.
- The stress of caring for livestock and pets are a prominent theme across EHHTs. While public health's first priority must be human health, the mental health load of caring for pets and animals should be considered in educational and outreach materials.

Many community members expressed the difficulties of evacuating, and this was not just from the EHHT events themselves making transportation difficult.

- Evacuating was expensive, especially for those who stayed at hotels for prolonged periods or for community members who hosted others and needed to pay for more supplies.
- Hotels and other shelters were often stretched beyond capacity within the region due to the amount of people attempting to evacuate.
- Many pet and livestock owners had issues with transporting their animals during EHHT events as well as finding places where they could house them.

Most community members are relying heavily on internet and social media based sources of information, even as they recognize the importance of both government-based and traditional news sources.

- While text-based alert systems are important– especially for quick notification– many people will need to follow up somewhere on the internet. Additionally, issues

with receiving text alerts or receiving incorrect text alerts arose, meaning the systems need to be improved.
- Development of clear, one-stop websites can provide trusted information and reduce stress.
- App-based information is also helpful. However, there are many apps being used, making coordination a bit more difficult.

Information vacuums breeds mistrust.

- Some comments about the 2018 Algal Bloom demonstrate that limited or changing information can result in stress and mistrust.
- The comments about electric utilities' hotlines being overwhelmed suggests care should be taken to scale information resources for widespread need during an emergency.

Perspectives from Residents in Marion and Polk Counties: Focus Groups and Community Member Interviews

Methods

Additional efforts were made to engage populations who might be less likely to engage in an online survey due to age, disability, or language barriers (i.e. new refugees or immigrant farm workers). Specifically, five group interviews (or focus groups) were undertaken.

- Newly-resettled refugees speaking Arabic (mostly from Afghanistan)
- Newly-resettled refugees speaking Ukrainian
- Latinx (held in Spanish) agricultural workers
- Advocates for the Intellectually and Developmentally Disabled (IDD)
- Older adults via the Center for 50+

While questions were changed slightly for each audience, all focus groups were guided by a semi-structured interview guide where participants were asked a series of open-ended questions about their experience with EHHT's. With their permission, the participants' responses were collected via electronic recordings; in cases where the focus group was held in a language other than English, transcripts were also translated. Transcripts were then coded using RQA methods similar to other data collection efforts in this assessment.

We also have included a summary for 12 direct community interviews within this section.

Focus Groups: Newly Resettled Refugees

Two focus groups with a total of 31 newly-resettled refugees were conducted during Fall 2023 in partnership with the organization Salem for Refugees (SFR). Adults from multiple countries were invited to participate by their case managers. To support participation we offered on-site childcare, light refreshments, and cash incentives in recognition of their time given. The first interview was with Arabic-speaking refugees and the second was with Ukrainian refugees. Translators from a local interpretation service were used to facilitate the discussion of both focus groups. Importantly, the Ukrainian interpreter hired did not speak Ukrainian, and thus the focus group was conducted entirely in Russian. All of the focus group participants spoke Russian, and thus this did not negatively impact the ability to conduct the focus group, but is important to mention.

The length of time participants had been in Oregon varied significantly, from several years prior to the focus group to only a week. This allowed multiple perspectives to be included, such as those that had lived through regional EHHT events, to the perspective of very newly arrived refugees with no prior experience with regional events. Details of each of the focus groups, including countries of origin, gender balance, and experiences are provided more in depth in the sections below. Focus group attendees were invited to attend a EHHT resource fair on the Willamette University campus, which was held several weeks later. The purpose of this fair was to provide newly-resettled refugee families the opportunity to meet with and learn about local organizations involved in emergency preparedness, planning, and care.

Arabic-speaking Refugees

10/23/23, Willamette Campus | 14 Attendees

The Arabic-speaking refugees interviewed originated from Syria and Afghanistan. Of the fourteen participants in this focus group, six were female and eight were male. Many were recent arrivals to the United States, and therefore did not have significant prior experiences with regional EHHT events. Therefore, there was a brief discussion on EHHT events followed by a more substantial discussion on communication pathways.

The focus group began by asking participants about environmental events that they associate with the United States. Participants mentioned earthquakes, floods, hurricanes, and fires. Because most participants were new arrivals, the participants had more questions about these events, rather than experiences of them in the US. In particular, participants asked about the cause of the Labor Day Wildfires, what city-level support is available to help residents be more prepared for fires, and evacuation strategies. Many

participants displayed interest in learning more about how to prepare for these events and how communication around EHHTs work.

When asked about the environmental events they had experienced in their own countries of origin, participants ultimately spoke of the effects of war, sharing that any environmental threat they felt in comparison was far less impactful. As the interpreter captured, "*he's saying that coming from war and all this, those things are nothing compared to the disasters that are happening here. We have been through worse"* with another participant adding *"air pollution. It's nothing"* in comparison to war. A major theme in this interview was the lingering trauma of war that many of the participants faced, even though the subject was mentioned only briefly twice.

Following the background discussion of familiarity and experiences with EHHT events, the focus group conversation then centered around communication. When asked about information sources, participants discussed talking with their SFR case managers, using the internet, and seeking additional information from organizations that partner with SFR. When asked about preferred methods of communication, participants shared that text was their preferred communication channel. As one person shared, "*phone calls are hard to understand. Not all people have a TV."* When asked in a follow-up question if there were to be a theoretical event, like a wildfire, how they might communicate amongst themselves and with the local Arabic-speaking population, participants shared that there was an existing WhatsApp group of Arabic speakers, which they were already using for communication and would use during emergencies. One participant shared that in Syria, mosques were a main venue for sharing this type of information, but that here they tend to get information through the schools, going on to say that *"sometimes, like emergency things, I can translate and put it in the group chat. In English and Arabic sometimes."*

Participants had a number of perspectives on how local health and emergency management agencies could help orient them to the local context. It was noted that very new arrivals often rely heavily on the networks made through SFR, and that it takes time to integrate into larger cultural networks. While they have not yet had major community gatherings given the recency of their arrival, the participants discussed having one in the future because *"it's important to have this group."* Gatherings like this can be used for future communication, and they agreed to that. One suggested that perhaps some of this information could be shared during their cultural orientation with SFR. When asked about which organizations they were uncomfortable with, there were not any immediately that came to mind for participants, but they noted that they had never given this question any thought either.

Ukrainian Refugees

10/29/23, Willamette Campus | 17 Attendees

The Ukrainian refugee focus group consisted of 17 participants, most of whom have arrived recently, following the start of the war in 2022. Thus, as with the Arabic-speaking focus group, many participants have limited experience with local EHHTs. The focus group proceeded in similar ways as with the Arabic group, beginning with a conversation about experiences with EHHT events and followed by communication preferences and networks.

When asked about EHHT events they were familiar with or associated with the US, participants spoke of winter storms and wildfires. A few participants discussed winter storms that had occurred in recent years, even though many hadn't been present during the 2021 Ice Storm. They discussed the difficulties of traveling via car, concerns about how to know if roads are cleared, and fear of experiencing regional wildfires. Earthquakes were also briefly mentioned.

When asked about communication preferences, participants shared a range. One shared that they prefer text because it is easier to translate the message. Another shared that they prefer emails and that there are group emails for communication that many, but not all, check. While some individuals use WhatsApp, it did not seem to be as central of a communication channel compared to those in the Arabic-speaking group. When asked about the language of communication, multiple participants said that sharing in Russian is sufficient:

> ***Interviewer**: Does it need to be in Ukrainian, Russian, or Both?*
>
> ***Multiple participants**: It can just be in Russian.*
>
> ***Interviewer**: And everybody will understand it?*
>
> ***Multiple participants**: Yes.*
>
> ***Participant**: Some people speak Ukrainian, but almost all - I think even all - Ukrainians understand Russian, so they can speak Ukrainian, but they understand Russian… Even if you send the information in English, people can use google translate… **so if the internet still works**, it is not a problem at all.* (emphasis added)

Some participants said that they had community events where it was possible for public health personnel to communicate with them while others didn't believe so. One proposed

that *"when we are gathering for a fun festival, maybe people would like to spend one hour studying."* Schools were also discussed as an opportunity to send information with one participant saying that children could *"teach their parents, like for earthquakes."* The participants also took high interest in CERT– Community Emergency Response Team– training and preparation.

When asked what would be specifically helpful for their community, participants shared a desire for first aid and preparedness training, including what to have on hand at home and how to access CERT training. For example, one participant had questions about the type of mask that should be worn during wildfire events. Another hoped for details on what type of food to store at home, and how much should be stored per person. There was also a desire for a map of county resources, such as different emergency shelters. There was also expressed interest in what to do during floods, wildfires, and freeze events. One participant noted that they were unsure who to call in the event of an emergency, stating, *"I was told not to call 911 by someone who speaks English because the police will take my name and make a report,"* and with an additional concern about a lack of English skills when making phone calls. Clarity of who to contact during various emergency scenarios was also asked for multiple times.

EHHT Resource Fair for Immigrant & Refugee Families

11/12/23, Willamette Campus | 46 Attendees

The research coordinator recognized that the focus group interview could create frustration and confusion among the participants, so she charged the students with the task of organizing a resource fair for the benefit of migrants and refugees in the area. In preparation for the resource fair, each student was assigned a local organization of relevance to EHHTs to research. The goal was to encourage the students to learn about the relevant organizations and to have the students reach out to invite representatives to the research fair. During this research, we were surprised to learn how many organizations were involved with emergency preparedness, but there didn't seem to be a central organization for these efforts. Additionally, we found this complex web quite confusing, and we further believe this justifies the idea that there should be one central agency, phone number, and well-known online site to prepare for and contend with environmental emergencies.

In early November, the class organized the fair replete with decorations, catered snacks, door prizes, and a considerable amount of printed material from the different organizations. Despite a considerable amount of outreach, the fair had only 46 individuals

attend, though several dozen others benefitted from the student-produced fliers that were disseminated through various organizations after the fair. Once again, transportation was a barrier for families, and with the lack of a concrete incentive to attend, such as cash, local refugee and migrant families chose not to participate.

Overarching Findings and Recommendations

Many refugees had little knowledge about the EHHTs that persist in Marion and Polk Counties. Providing some sort of educational material and preparation initiatives are key towards creating community resilience within this vulnerable population.

- Formally introduce refugee populations to the various local public service agencies that prepare citizens for potential health hazards and protect them during environmental events.

It should be noted that resettlement agencies don't immediately inform participants with information involving local environmental hazards because the refugees are already being given a massive quantity of information in the first few months. This is to avoid scaring refugees during this overwhelming time.

Central portals of information with simple and easy to understand information is important for refugees who face cultural and language barriers.

- Translated resources should be readily available to immigrant families.
- Public service information on websites needs to be clearly and simply conveyed. This helps the refugee understand the most important points that need to be prioritized. Simplified information can help improve the accuracy of automatic translation features in web-browsers.
- Many refugee families have children in public schools and have school-based text groups; pushing emergency information through this mechanism may help spread information.
- Human sources of information such as clinicians and phone operators should also be trained to help recently resettled families by speaking clearly, avoiding complex language, and recognizing cultural norms and differences.

Reducing the number of organizations working on disaster preparedness and response will make finding information far easier, especially for refugee and immigrant families. Creating a centralized website and phone number to go to for information would ease stress and confusion as well as quicken the spread of information.

Focus Groups: Latinx (Spanish-speaking) Agricultural Workers

On March 16, 2024, we held a three-hour Environmental Justice Community Mapping Workshop with eight farmworkers hosted in the Centro de Services Para Campesino (CDSPC) in Woodburn, Oregon. We worked through CDSPC's trusted networks to reach farmworkers. They recruited farmworkers to attend the focus group. The workshop consisted of a presentation about environmental justice, an asset and hazard sketch mapping activity, a focus group, and ended with a participatory hazard mapping exercise. The workshop was held entirely in Spanish. We provided food, childcare, and a modest incentive for participants. Eight students from Willamette University supported the workshop, and three faculty members were present.

Workshop Participant Survey

During the workshop, the attendees were surveyed about their demographics and their experiences with EHHTs. The group was evenly split by gender, and five participants identified as Indigenous, originating from states of Michoacan, Guerrero, and Oaxaca. One participant indicated they spoke Mixteco at home. Four farmworkers said that in the past six months they migrated and worked in California temporarily. Two farmworkers indicated they had lived in Oregon for only four years, but the majority of farmworkers called the Willamette Valley home for fourteen years or more.

When asked about environmental risk in the survey, seven said they worried about heat the most, followed by pesticides and wildfire smoke. There were also concerns for wildfires, air quality, water quality, and dangerous road conditions. All but one indicated that they worry about being able to pay their monthly utility bills. Only two farmworkers said they drink tap water from their faucet, and four farmworkers said they don't have access to potable water in their homes. Six farmworkers said they have had to stop working due to an extreme weather event. Two farmworkers said they suffer from asthma. In an open response section, two participants said they worried about the health effects of climate change because they did not have access to medical attention.

Focus Group Interview

A recurring theme in the focus groups was the exposure to extreme weather, but in particular heat. Farmworker women in particular described the practices they implemented to *aguantar*, overcoming over 100 degree days. This includes reminding children not to keep windows or doors open, which is difficult because children want to play outside rather than staying indoors. When high temperatures become severe enough, one worker describes how *"we can't work and we stay home,"* and *"we don't have this money to buy food, then."* During this heat, they also describe how crops spoil if they don't

harvest it soon enough, so their employers lose income as well. Some also bought AC for the heat, which *"was a great help to calm the heat,"* but this also caused electricity bills to rise, worsening already severe financial difficulties if they weren't working. Ice storms were also discussed multiple times, and the low temperatures and dangerous road conditions also impacted their ability to work. After the 2021 Ice Storm, a participant discussed how they purchased flashlights to have during a power outage.

For farmworkers, environmental and health hazards are also caused by their occupations. At the top of participants' concerns are pesticides and pesticide drift from other farms without warning. Weak enforcement rules around pesticide and chemical use mean that several farmworkers were subjected to poisoning without notice, had no access to PPE, hand washing stations, and even safe areas to eat at work. This exposure follows them even after they leave the workplace. One participant describes the problem like this:

> *"When we're in the fields, we work closely [with pesticides]. [There are times] when we aren't using pesticides, but the nearby ranchers are. The air brings the scent and that affects us…They don't give notice, but by night, we know."*

When it came to resources, participants identified their documentation status as a major barrier to being treated fairly and being able to access resources. Documentation status, language, and economic limitations place major strains in how farmworkers can actively seek information and resources, especially in times of crisis or disaster. For example, one stated:

> *"Because we're undocumented we can't go anywhere else. It's only here, this service, and this information. We can't go ask a government agency and risk our documentation status. So sometimes we need to find where we can find food, so we go to church."*

The quality of healthcare farmworkers receive is dismal. Some participants indicated it was hard to receive an appointment when they needed one. While the participants generally explained that they felt comfortable seeking medical attention when needed, they also questioned the quality of care they received, including for prenatal care. Farmworkers felt like many of their symptoms were continuously dismissed by doctors at local public clinics. Some felt like doctors did little to diagnose and prescribe medication, so farmworkers often opt for natural remedies. However, in more severe cases farmworkers are unable to receive appropriate care for chronic diseases, including cancer.

Farmworkers also reported mental health problems from chronic economic and climate stress. Farmworkers undergo major efforts to be able to maintain their well-being. Climate change and hazards heighten these vulnerabilities. Paying monthly bills, especially rent with the low wages they receive, puts farmworkers and their entire communities on the edge. Systematically, they attain little support. Farmworkers identified mutual aid as sometimes the only saving grace when an emergency strikes a family. The impacts of extreme weather and climate change pose compounding effects for farmworkers and double economic shocks. This causes major stress for households. One participant noted that *"what I see that I need here is called having family therapy or [mental health care.]"*

Farmworkers firmly follow social media channels of the trusted community organizations that provide direct service and support. The radio, including the work of Mano a Mano, was identified. However, farmworkers made it clear that social media doesn't reach every one, particularly recent arrivals that may speak Mesoamerican languages.

Overarching Findings & Takeaways

Designate a community resource center as an emergency shelter during extreme weather events for residents looking for resources, support, or a place for children to play during intense weather.

Improve communication and accessibility efforts between the government/aid agencies and immigrant communities, some of whom may be undocumented.

- Work with trusted community organizations and networks to share resources and information online and in person.
- Invest in providing information about emergencies, services, and resources in Mesoamerican languages.
- Remove immigration status barriers and communicate immigration status will not be considered in outreach efforts.
- Create a partnership among public health providers to improve access to doctors in person and also over the phone.

Allow agricultural workers to work with state and local governments to identify, track, and report illegal pesticide spraying and drift.

Improve access to health resources and economic relief, both for severe environmental events and for every-day hardships.

- Make PPE and emergency kits available to farmworkers, both during environmental events and during pesticide spraying.

- Create a program to distribute AC to farmworker communities.
- Increase access to mental health resources for agricultural workers; this was explicitly asked for by one participant.

Focus Group: Caretakers and Advocates for those Living with Intellectual and Developmental Disability (IDD)

Willamette University faculty conducted a focus group interview with care providers for people living with an Intellectual and Developmental Disability (IDD). There were seven participants who represented nonprofits, county, and state-level disability offices in varying roles, including emergency coordination, management, service provision, and clinical supervision. The interview lasted over an hour, and each participant was compensated for their time.

Ice storms were a major topic throughout the focus group. During the 2021 Ice Storm, dangerous road conditions inhibited care providers from traveling to and from work, but it was noted that they were able to use Lyft to help them. Additionally, some workers *"didn't want to go out because it was gonna be dangerous to their health,"* creating issues with providing care for people in need. The power outages during the storm caused issues for people who needed electricity to refrigerate medicine or use it for other care needs. Following the storm, care providers created ice storm heating kits because *"it was heartbreaking to see them like they were kind of freezing, like, huddled up in layers and layers and layers of blankets, because they had no heating."* Additionally, care workers began to provide solar phone chargers because *"that's a lifeline for many people who experience developmental disabilities, to have access to things like YouTube and critical things like that."* Another participant discussed using funds to pay for generators in areas with natural gas, in order to combat the power outages.

Wildfires and heatwaves were also discussed by the focus group participants. During the 2020 Wildfires, the participant who is a supervisor for Marion County Identity Services discussed prioritizing communicating about evacuation planning to individuals without a lot of support. During the heatwaves, one of the nonprofit workers discussed giving out cooling kits to people without AC and using grants to get some people with AC.

The mental health effects of EHHT events were discussed on people living with an IDD. One participant said their child's mental health declined by being cooped up during the ice storm and that *"it just brings a lot of stress and mental anguish when you're not able to get that done and not even able to get out."* One of the nonprofit workers discussed how they

had held mental health workshops during COVID, and this made it easier to be isolated during extreme weather events.

Communication was a major discussion throughout the focus group interview. Multiple participants felt that cell phones were the best or one of the best methods of communication. One described how *"when we couldn't be at work, we would utilize [cell phones], and quite frankly, it's probably something we're using to reach out to individuals."* Another participant added that they have a *"phone tree that we do to keep in touch."* In another discussion, one participant discussed how they created communication devices to keep people in contact with doctors and loved ones during COVID, and this can be applied to EHHT events. Later, one participant discussed creating interactive dollhouses to convey EHHT information to people with developmental disabilities. They described how *"making things accessible to people with developmental disabilities in ways that they can digest the information and that it's meaningful and then memorable to them."* Another participant mentioned the importance of emergency alerts, describing how they were *"getting better and better."* One participant who was a supervisor for Marion County Identity Services described how they used GIS to map out where their clients are so that they could specifically send them information and alerts based on the threat of EHHTs.

Overarching Findings & Takeaways

Ensuring that people living with an IDD have access to their necessary prescription medications is vital during extreme environmental events, so special protocols should come into effect during these times.

- Allow all people who need medicine– rather than just people with certain medications– to stockpile prescriptions, greatly reducing risk of illness, risk of mental health issues, and the risks of traveling in dangerous conditions in order to pick up medications.
- In the event of a power outage, create ways for people living with an IDD to store medication that needs electricity to keep from spoiling.

Expand investment to help people during power outages, including methods of communication, methods of heating, and ensuring that people with developmental disabilities have access to what they need.

Give various types of aid and preparation materials to families with people living with an IDD before and during EHHT events.

- Increase access to mental health care during and immediately after EHHT events, given the toll they can have on people's health, especially those living with an IDD.

- Care providers should help prepare families for evacuation or other actions before an extreme weather event occurs.
- Food giveaways have benefitted people living with an IDD during emergency events, according to some of the participants.

Promote interactive communication methods for people living with an IDD, as it will make the training more meaningful and effective, better preparing them for EHHT events.

Improve outreach and communication during an EHHT by improved alert systems, such as using GIS to send information.

Focus Groups: Older Adults at Center for 50+

On June 18, 2024, Willamette University faculty conducted a focus group interview at the Salem Center for 50+ with older Salem residents. Eight participated, all of whom were female. Every participant had lived in Salem for several years, and some had lived for thirty or more years in Salem. At least one participant didn't have a cell phone. The interview lasted about 45 minutes, and each participant was compensated with a gift card for their participation.

Multiple participants discussed the health risks which the 2021 Ice Storm posed, and these were discussed both in the context of leaving home and being stuck inside. Several participants discussed how they were unable to get prescriptions delivered due to the terrible conditions. One described how she was off of her prescription asthma medication for four days, and this led to her using a nebulizer. Another said she tested positive for COVID and needed to use Paxlovid during the Ice Storm, but she noted how *"I couldn't go anywhere, and I couldn't get the prescription delivered, and I ended up getting really, really sick and just having to tough it out."* Some of the participants noted how important their medications are, with one saying *"I can't live without my asthma medications."* While some of the participants discussed being able to stockpile medication, with one noting that *"when I'm down to only 30 days is when I get my next thirty-day supply,"* others discussed the inability to do that. One noted that *"you're not allowed to stockpile medication if you have certain things. I can't order medications until I'm almost out of medication, and so it makes it really difficult in this type of situation."* She later noted that in order to stockpile medication in the winter, *"the only way you can do it is to skip doses."* While several participants said that they had food and other supplies stockpiled during the ice storm, others didn't. One noted that Instacart wouldn't deliver for some time during the ice storm, and *"when Instacart finally would come out, then it was like– usually you get it within two hours, you know the most I mean– it was five hours before we got our first*

order." During a discussion on power loss, multiple participants discussed the loss of power or having family stay with them due to it. One discussed how their sump pump stopped working and how their basement would've completely flooded had they not traveled to a gas station to fuel their gas-powered generator.

During a discussion on air conditioning, several said they did not have air conditioning before the recent heatwaves, but many noted that they had it installed after the 2021 Heat Dome. When the interviewer brought up an Oregon program that uses Medicare funds for AC installation, the respondents had several questions about that.

When discussing accessing information, the preferred information sources mentioned were the internet and the TV. The participants were receptive to holding information sessions in preparation for weather events. One noted

> *"I have more memory issues. Okay? And it's harder for me to just get it,"* and therefore, *"having those things with people as we age– sometimes you need a little more explanation, you know, that would be good."*

In a later discussion, one participant noted that their friend tried to find senior-specific information hubs online for capped rent for seniors but were unable to, and another noted that *"they have those, but there's just a long waiting list."* In a closing discussion, the participants began to sign up for the Marion County emergency alert system, but they were very reluctant and intimidated by submitting information and creating an account for the system. No one completed the process during the meeting, and they only indicated that they would do it later.

Overarching Findings & Takeaways

Ensuring that older adults and people with preexisting conditions have access to their necessary prescription medications is vital during extreme environmental events, so special protocols should come into effect during these times.

- Allow all people with preexisting conditions– rather than just people with certain medications– to stockpile prescriptions, greatly reducing the risk of life-threatening illness and the risks of traveling in dangerous conditions in order to pick up medications. One participant even proposed this idea, saying *"there needs to be some allowances made for periods of severe weather that would allow you to kind of like have at least twenty or thirty days ahead of time."*
- In the event of a power outage, create ways for older adults and people with preexisting conditions to store medications which need electricity to keep from spoiling.

Information outreach should be made specifically to older adults in order to give them the opportunity to use aid policies for their benefit and keep them safe during extreme events.

- During discussions on recent policies that aided older adults, many of the participants were unaware of them, signaling that further promotion of them is necessary.
- The participants were receptive to holding repeated information workshops in preparation for extreme environmental events, so creating programs to host older adults throughout the year would increase preparedness and understanding of the threat while reducing risk.
- The participants were reluctant to sign up for alert systems that required personal information and technological savvy, so creating messages that would ensure confidentiality and help with technology would increase alert sign up rates.

Interviews with Community Members

An additional nine interviews were sought with community members who represented higher risk populations. These interviewees were self-identified through the community survey and/or suggested by county partners. Table 10 describes their role and linkage to various communities at higher risk.

Table 10. Interviewee Roles and Linkages to Higher Risk Communities

Interview	**Role**	**Linkages to Communities with Higher Risks**
Interview 1	Community leader	Underlying health conditions Intellectual or developmental disability
Interview 2	Elected official	Older adult Underlying health conditions
Interview 3	Community member from survey	Low income Unhoused Underlying health conditions
Interview 4	Community leader	Older adult Underlying health conditions Living with disability
Interview 5	Community and non-profit leader	Limited English (Spanish-speaking) Living with disability Outdoor workers Low income
Interview 6	Community leader	Limited English (Russian-Slavic) Living within fire zone Outdoor workers

		Older adults Living with disability Children Underlying health condition
Interview 7	Community member from survey	Older adult Underlying health conditions
Interview 8	County worker	Limited English (Spanish) Outdoor worker Underlying health conditions
Interview 9	Community leader	Older adult Living within fire zone Limited English Underlying health conditions

Overarching Findings

Winter Storms

Interviewees had concerns surrounding **response times** for first responders and the availability of first responders in areas such as Silverton and Woodburn. While the fire department or police were occasionally seen throughout these areas during specific winter storms, their presence and assistance weren't adequate. **Transportation** was another area of concern as many residents were stuck in homes without the means to acquire essentials, travel safely to work or seek help. Additionally, there was an overarching **lack of communication** between cities and residents on how to seek external resources, food, warming centers, and post-event resources (mental health and property damages), as well as help to clear debris. This was in part due to the inability to charge personal phones and connect to the internet. Suggestions for ways to reach communities when not able to utilize phones or the internet included placing signs with resources in neighborhoods, sending out teams to knock on doors, and employing the use of "hand" radio operators or neighbors with cell and internet access to communicate needs for their block. Additional suggestions included charging stations at key locations around the city, education on keeping phones charged, and purchasing power blocks for emergencies.

Low Income and outdoor workers in the Woodburn neighborhood expressed concerns about **not being able to safely work or access food** resources during ice storms. Since this vulnerable population often relies on daily pay for essentials, extra attention on providing information and access to transportation for essentials (food, warming centers, work) is critical. Food additionally was difficult to come by due to cash only in stores or a lack of ability to purchase adequate essentials in the stores that were accessible by foot.

Concerns were expressed about making sure resources for mental health and general health are available to residents during winter storms. Online programming (virtual activities and classes) for children who can't go outside during winter events was recommended by a nonprofit leader who had provided these resources to their community. For general health, access to medications was noted as an issue. Suggestions for this barrier included advance prescription refills ahead of large events or emergency prescription refills and transportation in the case of sudden winter storms.

Lastly, there was much concern about the length of power outages in certain communities. Specifically, Woodburn had outages lasting over two weeks. An interviewee noted it felt as though their power came on last and that they wished for their community to be prioritized and cared for during future outages.

Fires & Air Quality

Concerns surrounding fire and AQI ranged from the complexity of alerts and evacuation notices when determining evacuation plans, to having proper communications for certain vulnerable populations such as older adults and limited English speakers. Some older adults expressed that the fire season for many years was not as concerning as it is now and that reminders to prepare essentials for evacuations are needed.

Education was another area that came up when discussing fire. Knowing how fire conditions can change and what alerts are referencing, helped some residents feel more competent and calm when planning evacuations. Online wildfire preparedness and educational courses as well as knowing the risks associated with each resident's property contributed to a sense of preparedness.

A notable observation that one interviewee made was about **evacuations**. They noted that their community had issues with property loss while homes were abandoned. This created a hostile environment in the Russian-Slavic community that could have been mitigated by reassuring residents that their belongings were safe through more police or security oversight. This brings up a notable point that low-income or immigrant residents might be less willing to evacuate unless absolutely necessary to protect their property and belongings.

Concerns surrounding wildfire smoke were focused on older adults, residents with preexisting health conditions, and children. While residents have learned more recently due to wildfire events to properly protect themselves against high AQI exposure, low-

income individuals expressed how the construction of homes was worrisome to health due to higher exposure. One participant shared their experiences with living in a garage during poor AQI levels in 2020. This resident expressed how critical it is to create “clean air centers” or cooling centers with the dual ability to provide air conditioning and a smoke-free space for residents. This highlights an important point that poor air quality and heat can be simultaneous events.

Heat

Concerns around heat ranged from access to water recreation for children to heightened heat education for limited English and outdoor worker communities. Water recreation was mentioned as a necessity for communities with children. Woodburn was an area that expressed interest in seeing more water recreation opportunities during peak heat months.

Heat concerns for outdoor workers mainly centered on protections against heat exhaustion as well as mandating access to cooling areas and extra breaks.

Older Adults were concerned about heat-related power outages and accessing resources if and when they needed immediate access to cooling centers.

Additional EHHTs

Water quality was briefly mentioned, but not as a top concern, as well as seismic events. Seismic events were concerning for roughly half of the interviewees when discussing transportation and infrastructure (access to roads, bridges, and key resources post-earthquake).

Communication Pathways

Interviewees noted that communication was most difficult during the ice storms. While fire and smoke communications were more prevalent, they expressed that the messaging was overly confusing and hard to decipher in regard to each specific neighborhood or town. Confusion arose from the level of detail on alerts when trying to determine plans for households.

News coverage, word of mouth, city websites, first responders, government agencies, emergency alerts, social media, and radio were the main communication pathways utilized. Two participants representing limited English communities emphasized the need for radio, print, and social media communications to be sent out in all languages spoken. A suggestion was to utilize community leaders (Spanish and Russian) in these spaces to

properly spread information for their unique demographic. These leaders mentioned they have access to unique groups and forums (Facebook, Signal, Whatsapp, and Russian-Slavic Radio) that are used for communication within their communities.

Resources

- Neighbors were the main sources of assistance during winter storms
- Emergency alerts were useful when gathering information on wildfires, although sometimes information could be confusing or incomplete.
- City websites were used to gather general information about EHHT events and resources. However, it was difficult to find neighborhood-specific information or rural resources for certain interviewees.
- Food pantries were used during the ice storms, but it was difficult to access them by car or foot.
- Hotels for warming and cooling centers were very useful during the heatwave and ice storm. Interviewees wish more locations were available in rural areas.

Improvements & Recommendations

- More support in bordering county towns and rural areas is needed for all EHHT events, especially ice, heat, and fire events
- More neighborhood-led assistance during winter storms when there is a lack of communication is critical for the safety and the health of older adults, low income households, and other vulnerable populations.
- Alerts should be concise and straightforward, in multiple languages, and more area specific.
- Resources need to be posted in multiple media forms (print, digital, radio) and spread by key community leaders, networks, and organizations.
- Transportation is a large concern for workers who rely on daily wages, essentials, healthcare, and prescriptions.
- An emphasis needs to be placed on providing resources post EHHT event for mental health concerns, property concerns, and general recovery.
- Attention toward post ice storm resources and heat resources is needed. Examples could be resources on how to get an A/C unit or support groups for mental health concerns after large EHHT events.
- Better systems for city-resident communications need to be implemented as well as more first responder presence and accessibility when cell and internet services are down.

Perspectives from Community-based Organizations that Serve Populations in Marion and Polk Counties

Methods

We conducted semi-structured interviews with community-based organizations and other working partners and community collaborators engaging environmental hazards with vulnerable populations in Marion and Polk Counties. Organizations were selected through purposive sampling of those known to work in these areas, and supplemented through a snowball technique whereby interviewees suggested additional organizations we should speak with. A total of 72 interviews were conducted across a range of types of community partners (Figure 11).

Figure 11. Distribution of organization's primary purpose

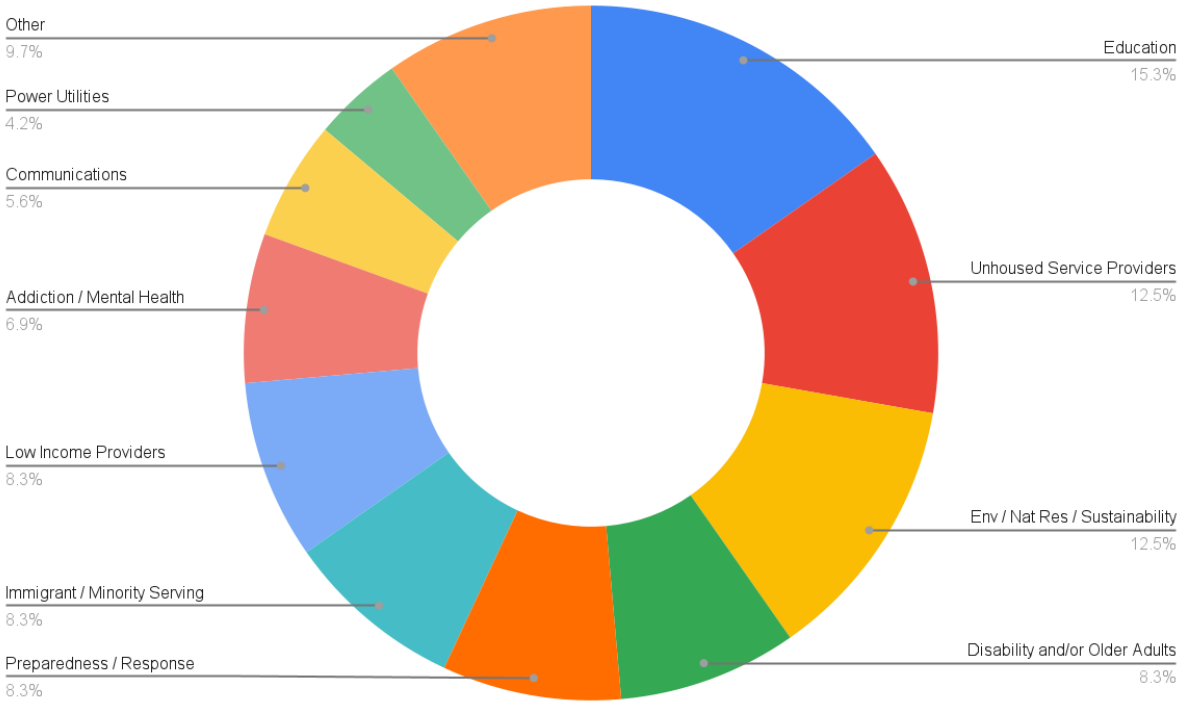
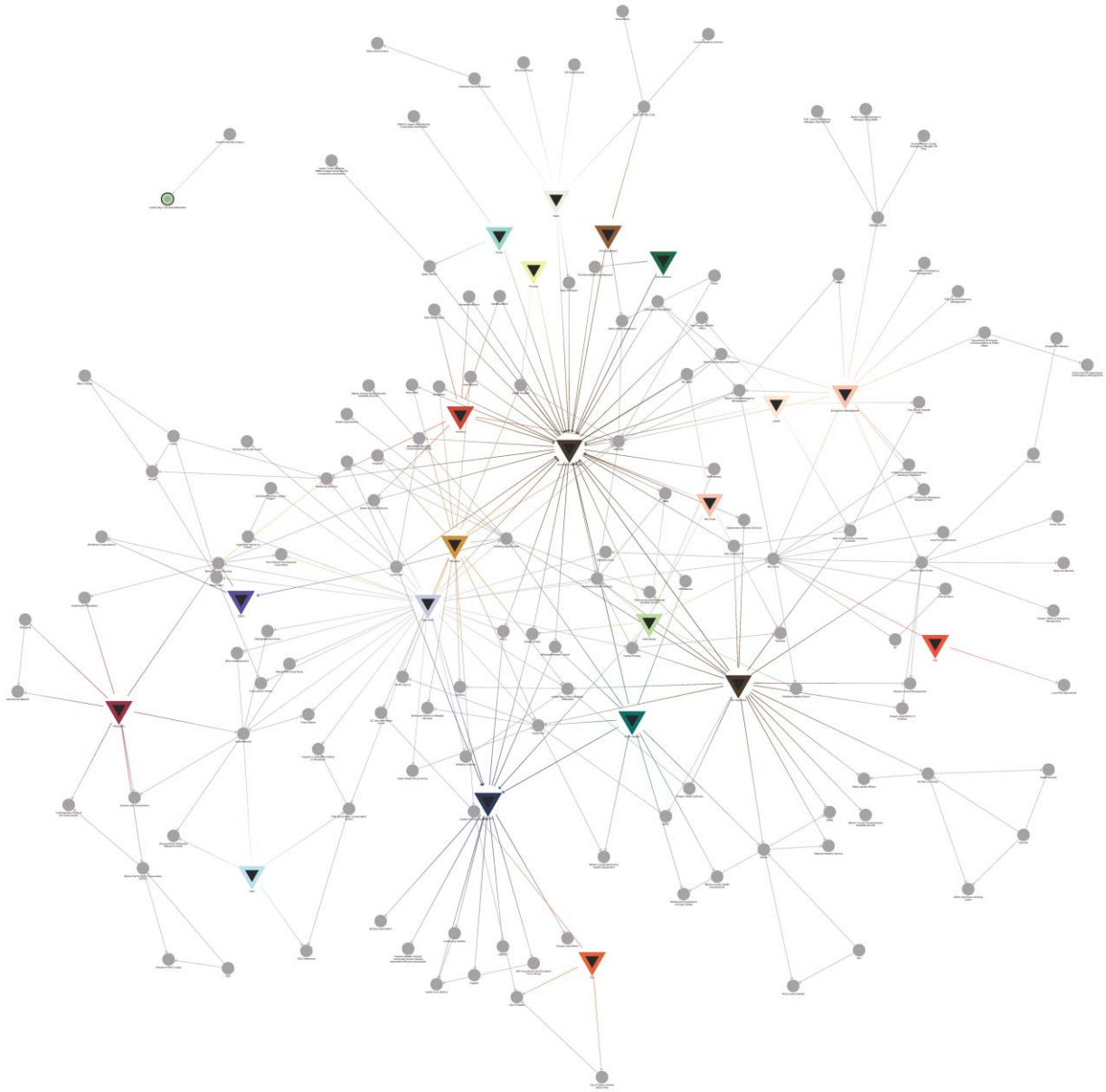


Figure 12. Draft example of linkages between community organizations as described in the semi-structured interviews.



Interviews were primarily conducted over Zoom, unless participants preferred in-person meetings. Most interviews were conducted by two trained student researchers using a predetermined semi-structured interview guide (see Appendix B) and took around 35-40 minutes. The interviews focused on:

1. The organization's experiences during past environmental health hazard events (EHHT), specifically the four described above.
2. Communication channels.

3. Strengths, weaknesses, opportunities, and threats.
4. Needs.

All interviews were transcribed and coded using a rapid qualitative analysis (RQA) framework. RQA, an action-oriented approach well-suited to health research, employs an indexing system linking interview questions to primarily deductively coded episode summaries, resulting in a matrix for analysis that allows qualitative research to be conducted in a relatively short period of time (Hamilton, 2013; St. George et al., 2023). Through matrix analysis, we identified common themes across interviews and examined differences and similarities based on the type of organization or EHHT focus. Key findings are presented below.

Key Findings: EHHT Impacts on Community Partners and Organizations

Interviewees were asked to describe their experiences during past EHHT events, as well as those of the populations that they serve. Interviewees told us a wide range of ways that EHHT events impact the populations they serve. Some examples include increased heating and cooling burdens on low income families during extreme heat and cold events, requiring financial assistance during the 2021 Ice Storm to prevent becoming homeless, worry about feeding a medically vulnerable child that relies on a feeding pump during the ice-storm related power outage, and experiences of unhoused individuals not feeling welcome at some community shelters during EHHT events. They also shared how they attempted to support the populations they serve during these events.

Organizations also told us about ways in which their operational capacities were impacted and some of their needs moving forward. These responses were sorted into the following categories, each of which is described in more detail below in a narrative form: Preparedness, Communication, Resources and Capacities, Collaboration and Jurisdiction, Geography.

Preparedness for EHHT Events

Many organizations told us that the recent EHHT events challenged them to respond to events that were, at the time, not prepared for. These events were significant learning curves for many organizations, and many organizations said that they are now actively working to increase their preparedness for EHHT, and are particularly looking to move from reactive to proactive stances. From this perspective of respondents, this shift could include multi-sector advanced planning, table-top exercises for different EHHT events, and coalitions of organizations that work with specific organizations engaging in more long-term (rather than short term) hazards planning. In particular, organizations are interested

in better preparing for the ways specific EHHT events impact the populations they serve. As one participant shared,

> *"[We] could use more planning before EHHT events occur. Some emergency events have more explicit plans, but not always in relation to specific vulnerable populations. The organization is* ***seeing changes in VPs and their needs****, and there is a new awareness of the need to include this new knowledge in emergency plans" (Participant*$_{SP24\_ENVS360\_001}$)

A number of organizations shared that they had been actively updating their emergency response plans in the wake of these events. Some organizations mentioned that it would be helpful to have more explicit training on developing preparedness plans, and to learn from other organizations that are further along in the planning process. A number of organizations also spoke of desiring additional training on topics such as trauma-informed responses to better support the needs of both their staff during events and the populations they serve. However, others spoke of the challenges of trying to update preparedness efforts. One notable barrier to increasing this type of preparedness noted is a changing political and administrative landscape. One participant noted that the politicization of environmental issues has resulted in *"extreme pushback"* (*Participant*$_{SP24\_ENVS360\_009}$) towards preparedness measures.

Communication During EHHT Events

A number of communication challenges during EHHT events were brought up. The first is the ability of organizations to receive and share information during EHHT events. One community partner said that they felt the communication was inconsistent and that the source information comes from varies depending up on the EHHT. For example, this participant (*Respondent*$_{SP24\_PHEAL399\_06}$) noted that they received information and instruction from their local police department during the 2021 Heat Dome and 2020 Wildfires, but did not receive any communication during recent ice events. Another mentioned that the timing of the 2020 Wildfires during the holiday weekend meant the office was already closed (*Participant*$_{SP24\_PHEAL399\_005}$). Not surprisingly, a number of organizations face challenges reaching populations they serve during power outage events, both because organization lines go down, as well as those that they serve. Longer term impacts were also noted. One individual who works for a local radio network that is a major source of information to non-English speakers, particularly migrant farmworkers, told us:

> *"The heatwave also impacted us, the forest fires also impacted us, we were off the air for three weeks on each of those occasions because our equipment was also damaged by the heat … The Ice Storm was a very similar situation, because our*

antenna in south Salem broke due to so much weight. It couldn't withstand the weight of the ice and it feel so we were off the air for a long time, almost a month" (Participant$_{SP24_PPLE399_03}$)

Resources, Capacities, and Other Response Needs During EHHT Events

While some organizations felt that they had good access to funding, particularly those able to access state and federal funding (the Inflation Reduction Act was mentioned by several organizations), many mentioned that funding was a major challenge for them. Some organizations were unsure where to turn to access funding, while others mentioned that the funding resources are constantly changing, or that the funding they do have access to is short-term and makes longer term planning challenging. The resource challenges extend beyond funding. While a number of respondents spoke of the willingness of their staff to respond to EHHT events, often spending extended periods of time onsite at evacuation shelters, for example, others stated significant challenges in this area. One interviewee commented that,

"It's difficult to ask staff to be available during an emergency…having people be first responders who aren't necessarily signed up in the role of first responders is difficult and expensive…And then it's compounded when it's expected time after time" (Participant$_{SP24_ENVS360_001}$)

Several organizations pointed out that their organizations depend heavily on volunteers to support their work and that a significant number of their volunteer base consists of older adults who are ultimately more vulnerable during these events and not necessarily able to respond. Still others mentioned they don't have the staffing or support they need to be able to respond at the capacity they would like during an EHHT event.

Transportation was a particular resource that was brought up in several ways. The first is related to evacuation. As one participant noted in relation to the fires,

"our biggest challenge was getting transportation arranged for our seniors who did not have transportation and some did not have a place to go. And I can't even remember when I found out that there was a Red Cross station set up at the fairgrounds. By that time, we had already placed our seniors with nowhere to go at the Holiday Inn here on Market Street in Salem" (Participant$_{FA23_PH301_006}$).

Transportation issues were also noted during the event. This includes individuals being unable to access employment, doctors' appointments, and pharmacies during the Ice Storm, particularly for individuals reliant on public transportation. Some organizations

mentioned that they have restrictions on their ability to transport people in vehicles and are thus unable to meet this need. Others are limited by the number of larger vehicles in their fleets that are used to distribute resources to individuals and families during events.

Another issue related to resources was the length of the recovery period. Interviewees discussed the ongoing and long-term impacts of EHHT events on property and people, and that continuing resources are needed to support these communities. For example, one interviewee highlighted that the full extent of the 2021 Ice Storm on rural landowners in Marion and Polk Counties is still unknown. Another stated in relation to the wildfires,

> *"Our families were impacted in probably every way that you can think of…by the time that they were able to get back into their homes, their kids had outgrown all of their clothes and their shoes, and all of the food that was in their refrigerator was no longer good" (Participant*$_{SP24\_PHEAL399\_012}$).

They went on to say *"For lots of our families, I believe the money is starting to run out, unfortunately. So, trying to figure out how to get them more funding, because families that can't afford to rebuild, they're still affected" (Participant*$_{SP24\_PHEAL399\_012}$).

The length of recovery impacted not only financial resources, but also staffing and mental health. One organization mentioned that staffing challenges are more pronounced during extended emergencies. Others mentioned the compounding nature of the events,

> *"In Oregon there were 3 disasters happening in September of 2020. You had a global pandemic, we had wildfires, and you also had the social unrest of the summer. And so those types of incidents layered one on top of the other will have an impact on the human body and the mind" (Participant*$_{SP24\_ENVS360\_005}$*).*

Collaboration and Jurisdiction:

As a whole, organizations spoke highly of the value of community partnerships, and expressed a desire to continue building more relationships that would strengthen their abilities to support the populations they serve during EHTH events. In recognizing the breadth of organizations in this area, some expressed a need for more centralization and coordination to avoid work duplication. One respondent in particular was concerned about what they saw as the siloed nature of local organizations, stating:

> *"[It's] hard to have a rational response to a region-wide event. Whenever you've broken your region so small and siloed people so effectively that, you know, a heat*

> *event doesn't respect a county line, but these responses do" (Participant$_{SP24_ENVS360_016}$).*

In a similar vein, one participant told us that they serve populations across two counties, but only got notification alerts for the county their organization is headquartered in. There were also concerns about role uncertainty. One participant noted that organizations aren't sure what their role is during an emergency. Another organization, one that provided warming centers during the January 2024 freeze, explained that they stepped in and set them up because, *"…the city wanted the faith based community to do it. And the faith based community really wanted the city to do it. So nobody was really doing it" (Participant$_{SP24_ENVS360_003}$).*

A number of interviewees brought up uncertainty regarding the chain of command. For one organization, they felt that they often were *"stuck to handl[ing[the situation by themselves"* while other organizations waited for approval from the governor to act (*Participant$_{SP24_ENVS360_012}$*). Another stated, "*I'm* ***still trying to understand that chain of command****. Does the city need to ask the county for assistance, and the county needs to ask the state?" Participant$_{SP24_ENVS360_003}$*).

When it came to inter-agency communication, one stated

> *"It seemed like all of the bigger organizations were talking amongst each other. And maybe there's a little bit of lack of communication to some of the smaller, local agencies, like watershed councils and districts and things like that. So it would be nice to know who to talk to and those bigger agencies. It's kind of hard to find a point person in such a large organization" (Participant$_{FA23_ENVS299_01}$).*

Geography

A final theme of note is that of geography. While this was not mentioned as frequently as some of the others, given that this project spans two counties, it is worth highlighting what was mentioned. A few participants brought up differences in Marion and Polk Counties. One participant asked for Polk-specific concerns to be highlighted in the report, reflecting concerns that their needs may be obscured by Marion's. Below are some Polk County-specific concerns that were mentioned by participants:

- Referencing planning documents, one community partner serving unhoused individuals suggested that Polk County is not prepared to specifically support unhoused folks during EHHT crises. They do note that the Polk County warming

center network is very strong, and could serve as a model for cooling shelters (*Participant*$_{FA23\_PH301\_005}$).

- Another unhoused-focused organization learned from the ice storm that there is *"No reliable public transportation in rural areas of Polk County"* (*Participant*$_{FA23\_PH301\_001}$). This was echoed by another environmentally focused respondent who stated *"Because of their proximity to Salem, people [planning] overlook their transportation issues in Polk"* (*Participant*$_{SP24\_ENVS360\_018}$).

- A Polk County community partner said *"Something that I've heard from people who are affected by those events was just that they heard very little from agencies in the area, especially folks who they thought would get assistance quicker, or would at least have some warning or feedback or here's what you need to do to get help"* (*Participant*$_{FA23\_ENVS299\_001}$).

- An environmentally focused community partner suggested that Polk County is *"a bit of a water poor county,"* so it's always a challenge to balance conservation desires to keep water in streams versus landowners' desires to capture and store water (*Participant*$_{FA23\_ENVS299\_002}$). Similarly, water in the form of droughts or pipes bursting is briefly mentioned by another participant as a cause for concern within Polk County communities. She mentions her worry that water is becoming a scarcity (*Participant*$_{SP24\_ENVS360\_018}$).

- Prioritizing population centers can be difficult for those in Polk County. One participant said *"I do know, in rural Polk County it was weeks to get lights and things back up. That's concerning to me, right… to have families that were in the freezing cold for, you know, weeks on end."* (*Participant*$_{SP24\_ENVS360\_018}$). This same participant went on to note *"There's still a lot of poverty in Polk that's not talked about"* (*Participant*$_{SP24\_ENVS360\_018}$).

While the RQA allowed for a quick search of mentions of Polk County, we did not explicitly analyze the qualitative interviews by county; thus, we do not have a comparable list of Marion-specific concerns.

Additional geography specific concerns brought up by interviewees included (1) that rural homelessness in the region is often overlooked, (2) that Woodburn organizations are sometimes left out of larger regional conversations, (3) that the recent EHHT events have been a learning opportunity and wake-up call for many about local risks, and (4) that Silverton has limited evacuation options during wildfires, limited capacities to provide aid to elderly residents during wildfires, and lacks a specific space to provide to older adults during EHHTs, such as the 2021 Heat Dome.

Higher-risk (Vulnerable) Populations

To further examine the experience of the organizations interviewed, we looked at responses brought up in relation to specific populations at higher risk of exposure or health impacts. These are organized by population in

Table 11 on the following page.

Table 11. Concerns of community-based organizations by specific population

Population	Concerns / Experiences of CBOs that serve the population
Non-English speakers	● Many concerns about not being able to reach non-English speakers. ○ Noted lack of information available during EHHT events in languages other than English. ○ Some agencies had support for Spanish, but a number didn't have Spanish support. ○ Organizations without individuals on staff from these communities want to know more about cultural context to better communicate with these groups. ● For community-based organizations that did their own translations: ○ There was concern about their ability to produce translations in a timely manner, especially if they weren't getting information in English quickly. ○ The delay in doing the inhouse translation meant that the information that reached these groups was lagging, and sometimes resulted in misinformation if the situation had changed. ○ Some of the members of the populations they serve do not read, so they also had to translate oral messages. ○ The translation process could be very stressful for those doing the work. ● Overall, there was need for increased and timely access to Spanish and other non-English language materials during EHHT events to share with their communities.
Underlying Medical Conditions	● Acknowledged by organizations that underlying medical conditions compounded risk to EHHT related health issues. ○ Unhoused have higher rates of chronic illness. ○ Individuals reliant on medical devices + caregiver dependent + in-home care combined are in a "dangerous position" during EHHT events. ● There have been increased efforts to engage households dependent on medical devices before power shut offs, by power companies and community-based organizations. These efforts include: ○ Advance warning of shut offs; ○ Increased messaging and alerts; and ○ Preparation outreach. ● However: there was an expressed need to have better systems to *check-in* on these groups *during* EHHT events.
Children	● Infrastructure concerns:

	○ Many schools do not have AC. ○ Schools are concerned about heat exposure to children, especially those without AC at home and thus get no respite from the heat. ○ Balancing heat and air quality is a challenge in older buildings. ○ Schools sustain damage during events. ● Cancellation of classes, programs, events: ○ Challenging for students, and families dependent on child care. ○ Disrupts access to resources (food, support services). ● Unhoused youth: ○ One participant noted that their organization supported many displaced teenagers from the wildfire. ○ Unhoused youth can be hard to reach with information because their cell phones / numbers may change a lot. ○ Unhoused youth don't know where to go or where to get information from during EHHT events. ● I/DD youth: ○ Can experience impacts from disruption to routine and assistive devices during EHHT events.
Older Adults	● A wide range of programs to support older adults were mentioned, such as through the Older Americans Act. ○ Some examples: home delivered meals, older adult peer mentoring, caregiver support through Relatives as Parents' Program (RAPP). ● However, many challenges were reported by organizations that work with older adults, including: ○ Lack of access to affordable housing. ○ Mixed success in efforts to increase air conditioning in homes. ○ A long wait time to access services. ○ A lack of support system and isolation during events. ○ Wide range of abilities and needs across the population . ○ Homeshare model suggested as an option to lower housing costs for both parties, and pair older adults with someone that can support some of their needs. ● Many volunteers of organizations that respond to EHHT events in communities are older adults themselves. ● Some locations lack designated spaces to open for older adults during emergencies (ex. Silverton).

	● Transportation for basic necessities and medical needs can be particularly challenging for this group during events: ex. poor road conditions, low visibility due to smoke.
Outdoor workers	● Many farmworkers continued to work during heatwave and smoke events. ○ This had negative impacts on their health. ○ When workdays were cut short due to conditions, they were impacted through lost income. ○ There are often fewer harvest hours with good conditions in a day than there used to be. ○ Community-based organizations stated workers preferred to work during these events, so strong focus needs to be on how to make the work safer. ● Concerns of deportation may influence resource seeking during EHHTs for migrant farmworkers. ● Emergency services would benefit from additional training around trauma in this population (culturally appropriate, engaging with service providers).
Unhoused / Housing Insecure	● All EHHT events amplified challenges regularly faced by this group, i.e. heat/cold exposure, power outages, access to clean water. ● Power outages are major problems for this population and something that is a constant struggle. ○ Power to charge devices can be hard to find. One interviewee mentioned that OHP may try to take powered medical equipment back if users cannot find electricity to reliably use it. ● Reduction of library hours is a concern regarding heat exposure and burden among unhoused. ● Communication: ○ Can be challenging to communicate with this population. ○ Many are reticent to receive information from police. ○ Gas station bathrooms and convenience stores mentioned as places. to spread information, like cooling / warming center locations. ● EHHT events put more people in need of resources, which tend to push out unhoused people from accessing them. ● EHHT response team similar to mental health crisis response for this population was suggested as something that would be useful.
Disability	● Needs within this population are very vast, including mobility impairment, intellectual and cognitive disability, D/HH, blind / low vision, thus

	challenges and needs vary significantly. Some important things brought up by community-based organizations include: ○ Lack of accessible transportation - in an evacuation there needs to be a plan in place to pick up individuals and bring them to evacuation center. ○ There were challenges accessing water distribution sites during the algal bloom. ○ Reserve funds for organizations to respond during these events would be ideal. ○ Change in routine during an ice storm is challenging for some autistic children. ○ Single parents of children with disabilities are a group that can be particularly impacted during these events, but not often considered.
Low income	● Expense of preventative changes to home to lessen EHHT impacts is costly and prohibitive, as is building a stock of supplies. ● Low income communities experience increased trauma from EHHT events. ● Financial situation limits ability to make repairs or rebuild after events - including bills and being underinsured or uninsured. ○ EHHTs also impact plants and trees, which may be costly to replace (and may have longer term impacts on heating / cooling of the home). ● Inequitable distribution of heating and cooling units, with high energy bill burdens for lower income households that do have access to AC. ● Large population of Polk County children live in poverty.

Key Findings: Communication Channels

To answer RQ4, the 72 community partner interviews were analyzed for what type of information is commonly being shared, how they are communicating this information, who they are communicating this information to, and where they are getting their information from. 80% of community partners interviewed reported that they share general emergency information when EHHT events occur. Many of the organizations that were interviewed did not explicitly state what kind of information they communicate during EHHT events. However, they frequently reported sharing information about emergency preparedness, health risks, available resources, and emergency shelters. Providing information in languages other than English is also an important part of communication for 13

organizations. Of those providing information for non-English speakers, the majority provide information in Spanish. Additionally, one interviewee provides information in Mesoamerican languages and another in languages spoken by the Micronesian Islander community. Several organizations only communicate about certain EHHT events or impacts related to the function of their organization, such as how utility providers focus on power outages and forestry departments prioritize information about wildfires.

Social media is the most frequently used communication platform among community partners with 55% reporting that they use social media to communicate with the populations they serve. Of those, 50% stated that they use Facebook, 10% use Instagram, and 10% use Twitter/X. Email is also a common communication method, and 27% said that they use email to communicate with their populations. Interviewees also noted that word of mouth is critical for sharing information about EHHT events with vulnerable populations, with 26% reporting that they rely on this method for communication. Phone calls were also useful for contacting target populations and ensuring they receive information, with 22% of community partners using this method. Additionally, radio, websites, and emergency alert systems are frequently used for communication among various organizations. Other common communication tools include texts, newsletters, messaging apps, signs and posters, newspapers, and TV.

Table 12. Types of communication channels discussed in community partner interviews

Communication channels used by Community Partners:

- *Social media:* Facebook, Instagram, X, websites
- *Phone network:* Phone calls, texts, group texts
- *Traditional media sources:* Cable, Radio (preferred for rural areas)
- *Community / Cultural events:* prevention focused
- *In-person check ins:* during disaster events
- *Word of mouth:* to reach population without access to phone / internet
- *Public information boards:* Park boards
- *Info from federal/state/local agencies:* weather apps, push notifications, PSA
- *Internal comms:* website, newsletters, networks, comms stuff, partnerships

Communication from community partners is generally targeted towards both the general public and specific vulnerable populations, with 62% reporting that they communicate with vulnerable populations and 27% with the general public. Of those that communicate with higher risk populations, 17 organizations communicate with the unhoused, eight with the Spanish speaking community, four with older adults, four with individuals with disabilities, three with farm workers, two with youth, one with communities of color, one with Tribal communities, and one with the Micronesian Islander community. It is possible that there are other organizations that communicate directly with vulnerable populations,

but are not included in this count if it was not specifically mentioned during their interview. Community partners will also communicate with other community organizations and local media sources to amplify messages and reach a wider audience.

There were a few key takeaways from the community partner interviews regarding communication pathways and communication with vulnerable populations.

- **Stakeholders commented that communication networks and relationships with other community organizations and leaders play a key role in communication during EHHT events.** They rely on these networks to receive and share information about EHHT events, which ensure that communication reaches more people.
- Community partners noted that **social media is generally effective because it can reach a wide audience and information can be easily shared amongst organizations** and other platform users. However, some cited concerns about relying too heavily on social media due to the potential for misinformation.
- It is important to **use a wide variety of communication methods to ensure people receive critical information**. Community partners recognized that multiple methods of communication are necessary to meet the needs of the populations they serve. Certain communication tools may be more effective with some groups than others, so it is important to provide communication using the preferred method of the group being targeted.
    - While social media and Facebook are frequently used for communication, older adults are less likely to use social media and younger generations may prefer other social media platforms, such as Instagram.
    - Digital news sources are also not an effective way to reach the unhoused population as many do not have access to digital devices or the internet, and instead word of mouth has proven the best way to communicate with this group.
    - Similarly, older adults may not respond well to digital news sources, so it is important to provide print news sources or facilitate phone calls and in-person conversations to get information to this group and ensure they are prepared for an EHHT event.
    - It is also critical to provide information in languages other than English, and for translations to be immediately available because delays in communication may prevent groups from effectively responding to an EHHT event.

Key Findings: SWOT analysis

Interviewees were explicitly asked about the strengths, weaknesses, opportunities, and threats faced by their organizations. Their responses were coded and organized into the table below. Because the analysis spanned approximately 70 organizations, not everything in each box applies to all organizations, and in some cases may run counter to an

individual organization response. For example, while some organizations felt that their preparedness was a strength, others felt theirs was a weakness. The bullet points below each bolded theme highlight some of the characteristics of associated organizations. For example, organizations that felt that preparedness was a strength mentioned things such as scenario planning internally and in collaboration with other agencies, and having predetermined decision points that would trigger responses in EHHT events. Organizations that are not as well prepared mentioned things such as not being prepared for year-round events, or being limited to earthquake preparedness, or being uncertain how to support the population they serve during specific events.

Table 13. SWOT Analysis Summary Matrix

STRENGTHS	**WEAKNESSES**
Adequate amount of resources / preparedness ● Effective communication among community partners (CPs), Emergency Management (EM), and public ● Scenario planning for different events internally, and with other CPs and EM ● Resources in place for different scenarios ● Predetermined decision points Communication and outreach ● Effective internal communication ● Good use of social media ● Wide set of tools to reach population ● Existing communication networks between CPs, public, EM allow for effective communication ● The populations they serve respect and trust them Sufficient staff and support ● Enough staff to support organization ● Staff oriented towards supporting VPs they serve ● Willingness to learn about EHHTs (scenarios, resources, preparedness) ● Staff that let clients lead re: needs Community partnerships ● Networking across organizations - for funding and partnerships	Lack of resources / preparedness ● Not enough funding (especially for translation and community events) ● Limited information for preparedness: only prepared for a limited number of scenarios, such as earthquakes, or only one season) ● Not prepared for how to help their specific populations during EHHT event ● Staff can't get to site during emergency ● Have not thought through access issues in advance, for example, ADA compliance and accessibility Communication gaps ● Ability to reach specific vulnerable populations, particularly non-English speakers, tribal, refugee, local (for state agencies) ● Don't have access to translators and or translated materials ● Communication between organizations is challenging during events ● Not being able to get messages out quickly enough ● Trouble reaching populations that don't have or use tech (including older adults) Staff and support

Community involvement ● Staff come from the same populations the organization services ● Active volunteer network ● Established relationships in the community ● Allows them to understand the specific cultural / community context of the populations they serve	● Need more help developing Emergency Response plans ● Don't have enough staff, which limits who/how they can assist ● Lack of time to maintain relationships and develop external collaborations
OPPORTUNITIES *Partnerships* ● Organizations value or are trying to strengthen relationships with state agencies and other local organizations *External funding* ● Inflation Reduction Act, OHA, modernization, and county support have all been very helpful *Communication* ● Strengthened partnerships would allow for more accurate and timely information sharing *Education and Learning* ● Community partners expressed a desire to learn from experiences of other agencies, and more about local EHHTs *Planning and preparedness* ● Many community partners see an opportunity to move from reactive and towards proactive EHHT planning ***See spotlight on opportunities below for additional details	**THREATS** Funding ● Small budgets, trouble accessing grants Community Engagement ● Challenged by beliefs about climate change, burnout, lack of knowledge re: EHHTs events Local context ● Increasing frequency of EHHT events (strain operational capacity, bring in even more individuals needing support, which impacts those they currently serve) ● Limited bridges impact response across the two counties ● Spread / expanse of Marion/Polk counties ● Weather during response ● gaps in citywide services and gaps in what to do in an emergency

The "Opportunities Spotlight" on the following two pages more comprehensively outlines the opportunities voiced in response to the question *"What external opportunities do you see for your organization to support efforts to better prepare and engage the community around resilience to environmental hazards and threats?"* A total of 120 different

opportunities[2] described by participants were pulled from the interviews, coded, and grouped into the key categories of Partnerships (42.5%), Funding (12.5%), Communication (11%), Education & Learning (12.5%), Planning & Preparedness (7.5%), Engagement with specific community groups (8%), and Legislation (6%). The percentage of opportunities that fell within in of the categories is also provided to help contextualize the most common responses.

[2] The percentages associated with each category reflected the number of coded responses in that category out of 120.

Spotlight on Opportunities

Partnership Opportunities (42.5%) A wide range of external partnerships that organizations hoped to strengthen include: local emergency management, county health departments, public school districts, local universities, churches, city leadership and government, local emergency responders and police, state agencies, other organizations that work in the same or adjacent fields.

The value of external partnerships included:

- Collaboration and sharing of resources:
  - Collaboration is helpful for problem solving and preventing duplication of efforts.
  - If a specific organization can't help someone, it is important to know what organization can.
  - Data that can be used in reports, grants, or other materials. For example, one participant suggested developing a system to collect resources available and creating a public map.
- Ability to leverage communication channels.
- Organizing community events.
- Learning from other organizations:
  - About their disaster / emergency preparedness plans.
  - That have expertise with specific EHHTs or working with vulnerable populations.
- Network building:
  - The importance of different perspectives and areas of expertise.
  - Some organizations felt they needed to do a better job of getting word out about what they do.

Organizations were interested in more intentional collaborative planning for EHHTs events with partners. Many saw a role for county health departments and emergency managers to guide planning efforts and to support relationship building in advance of EHHT events. In particular, interviewees said it was hard to know who had and who needed specific skills and resources, and how organizations fit together during EHHT events.

Funding Opportunities (12.5%) used or viewed as potential future possibilities included OHA grants, other Oregon specific grants, Inflation Reduction Act (for sustainability, infrastructure, equity, and EJ to support hazard response and mitigation), EPA, OREM resilience hub and network grants to build community resilience.

- Funding is a key opportunity, but some organizations need more support accessing grant money.
  - Some need information on what grants are available, and others need support applying.

    - Restrictions and timing of grant cycles also impact the ability of some to go after grant support.

- Some organizations see themselves in a position to help communities or smaller organizations access grants, or otherwise see leveraging partnerships as a way to support accessing grants.
    - Example: helping homeowners apply for support to make homes and yards more fire resistant.
    - Example: local universities supporting smaller organizations in their funding applications.

Communication Opportunities (11%)

- Increased collaboration with other agencies to support communication messaging:
    - Particularly to increase the reach of messages;
    - Strengthening relationships would allow for faster and more timely sharing of information.
- Increased outreach in advance of EHHT events:
    - Getting word out to specific groups sooner;
    - Increased sharing of information at sites of services (example: having multi-lingual fliers).
- Finding ways to reach groups that are reluctant to receive some types of climate-related messaging
- Ongoing need to improve messaging to foster individual preparedness

Education / Learning Opportunities (12.5%) for continued learning that would be helpful include:

- An overview of who the key actors and agencies are they should be looking to for guidance on EHHTs, and the resilience plans / efforts underway at the local level.
- Learning about the local EHHTs of concern in Marion County.
- Opportunities to learn about the experiences and lessons learned of other organizations from past EHHT events.
- Increasing knowledge about the skills of other organizations.
- Training on disaster preparedness / resilience.

Importantly, while organizations desired learning opportunities in some areas, they also spoke of how they see their own areas of expertise as an opportunity to leverage for others that don't have expertise in that area or for communities they serve.

Planning / Preparedness Opportunities (7.5%) stressed the need to move away from reactive and towards proactive planning when it comes to EHHTs. Key needs related to this echo those in other sections:

- More support for advanced hazards planning and longer-term collaborations.

- Ongoing community (and multi-community) conversations with other organizations, and local key players (county, emergency management, etc) about preparedness.
    - Include coalitions of organizations that work with vulnerable populations.

Engagement with specific community groups (8%)
Some organizations mentioned engagement with specific community groups as opportunities. These include:

- More community meetings with specific populations they serve:
    - Help the community understand who they are & what they do.
- Attention to the spaces where communities are engaged:
    - This includes increased outreach in spaces that are meaningful to the particular community
    - Some stressed the importance of creating healthy community spaces and third spaces as essential to building community relationships and resilience.
- Because the volunteer base for many organizations is older adults, some organizations see an opportunity to increase the involvement with younger adults in emergency response.
    - This may be adults in the community, and/or college students.

Legislation Opportunities (6%) included engagement with the legislative process and officials, such as:

- Advocating or supporting specific legislation, or developing programs as a result of legislation.
    - Areas mentioned include: community fire protection, zoning and housing laws.
- Engaging elected officials (either directly or through partner agencies), specifically: mayors, county commissioners, governor's office.

Community Partners Serving the Unhoused

Homelessness is a pressing social concern across the nation, and worsening in overall numbers according to the HUD Annual Assessment Report for 2023. In Marion and Polk Counties the unhoused (also known as unsheltered or as persons experiencing homelessness, homelessness, or housing insecurity) are served by a number of local community partners and service providers who provide a variety of proactive and responsive forms of social services and assistance. These providers vary in mission, scope, and size of staffing and volunteers, and include governmental operations, as well as contracted and charitably funded non-profits that are secular as well as faith-based.

In Fall 2023 and Spring 2024, research on EHHTs and the unhoused took 3 forms:

(1) A review of recent scholarship and gray literature;
(2) Interviews[3] with 20 representatives from 18 distinct Service Provider organizations (henceforth providers) located in Marion and/or Polk Counties using an open-ended scripted instrument; and
(3) Intercept interviews with 20 unhoused individuals in Salem using a truncated open-ended script.

Key findings

Findings from the three sources confirm that the unhoused are extremely vulnerable to EHHTs and that providers struggle to respond adequately. The unhoused are more directly exposed to environmental factors than the housed and hence especially vulnerable to EHHTs. Moreover, when EHHTs affect the wider population, and emergency services are spread thin, the unhoused are typically less able to access or advocate for their needs. Further, most EHHTs also adversely impact the staff, volunteers and facilities of providers.

Communication mattered to providers in three respects: conveying crises and responses internally, networking across organizations and in the wider community, and reaching the unhoused themselves. Provider representatives felt most functional when kept informed and able to update themselves on current events. Many receive their information through media sources such as the news and social media, as well as other organizations they are partnered with. However, some organizations with more established divisional structures have staff dedicated to identifying population needs and keeping everyone informed.

[3] These interviews are a subset of the interviews described and analyzed in the previous section.

According to providers, there are two main types of EHHT content that need communicating across organizations and into the wider community: updates on ongoing EHHT events and where, how, when and which services to access from which community partners. Specifying both is crucial, but so are the methods of communication to ensure that the information is received in a timely and intelligible manner by diverse audiences. Provider communication with the unhoused took four principal forms: (1) conventional and social media, (2) on-site posted and verbal, (3) direct face-to-face outreach, and (4) word of mouth among the unhoused.

SWOT Analysis Specific to Unhoused

SWOT–Strengths

- Since December 2019 a Continuum of Care (CoC) organization, the Mid-Willamette Valley Homeless Alliance (Alliance) has operated a CoC Collaborative Committee in which most of the local providers participate. Communication and coordination of programs and providers with the unhoused has improved markedly under the auspices of the Alliance.
- Representatives of most providers self-reported having appropriate organizational and decision-making structures and good internal communication under ordinary circumstances.
- Provider staff demonstrate high commitment to their work, and draw meaningfully upon personal and familial past and present experiences with homelessness. Volunteers were essential and especially so during EHHT events.
- Emergency medical facilities play vital roles of last resort for the unhoused.
- The Governor's Emergency Decree and additional budget allotments at state, county and city levels have eased the resource constraints, and increased the volume of temporary and transitional housing.

SWOT-Weaknesses

- Under normal circumstances, resources and supplies do not adequately meet the needs of the unhoused. During EHHT crises stockpiles of emergency supplies were rapidly exhausted and timely communication more difficult. Many of the service providers were somewhat underprepared and overwhelmed, commenting frequently on the challenges they themselves experienced during these events.
- Notwithstanding the expanding supply of stable housing options, some among those interviewed expressed frustration about the backlog of applicants and behavioral rules for eligibility to them.

- Undertaking the Point-in-Time (PIT) count remains a local challenge. Having opted out in 2024, the Alliance has sought proposals from qualified external contractors for the forthcoming required cycle, 2025.

SWOT Threats

- The unhoused remain especially vulnerable to EHHTs due to both increased exposure to the elements and underlying individual medical and social risks. Moreover, most EHHTs also pose hazards to provider staff and volunteers and thereby inhibit their abilities to inform and protect the unhoused.
- There are converging systemic reasons to expect the frequency and severity of all forms of EHHTs to continue if not compound and worsen in the region in the future.
- Beyond the direct health impacts of environmental extremes, losing power during EHHTs is very detrimental since both heating and air conditioning rely heavily on power. Service providers that lose power cannot provide services. Additionally, losing power adds a significant barrier to communication and rapid decision making.
- Public sympathy for further interventions to ameliorate the conditions of homelessness and to assist the unhoused with stable housing and services fluctuate in ways that can help or hinder future societal supports and funding.

SWOT Opportunities & Recommendations

1. **Routinize PIT Count** and continue applications for federal (HUD) and state funds and innovative programmatic supports (HUD) to further address homelessness.
2. **Provide fuller EHHT-specific coordination** of providers through the Alliance, as part of society-wide EHHT communication and response efforts.
3. **Ensure efforts occur both in Marion and Polk Counties,** where attention has lagged until recently, and in smaller communities within the two counties, including Woodburn, Silverton and Detroit.
4. **Set aside resources and supplies for EHHT emergencies.** Material stockpiles – including items such as portable air conditioners – should be maintained in anticipation of future EHHT-related collective needs.
5. **Coordinate further with Medical Centers.** Additional collaboration and coordination with healthcare providers, such as Salem Health Hospital and Salem Health Community Health Education Center, should occur.
6. **Provide support for provider staff and volunteers during EHHT crises.** Most EHHTs impact everyone. Preparation for future EHHT scenarios should include ensuring that the facilities of providers are stable during extreme events.

7. **Expand EHHT outreach.** Providers should be prepared to expand outreach on the model of mental health crisis response, and with the capacity to transport the unhoused and secure their possessions as needed.
8. **Establish a communication infrastructure**. Communication with the unhoused should be multilingual, accessible, and continue to rely on four forms: media, on-site, outreach, and word of mouth. However, the Marion Polk Alerts system should be further developed and assistance in using it provided to target vulnerable groups including the unhoused.
9. **An EHHT-Unhoused communication plan should include the public.** Civic communication channels and online periodicals can raise supportive public awareness and involvement. See for example, the current weekly City of Salem 'Responding to Sheltering in Public Spaces' newsletter, and the periodic Marion County 'Health Promotion & Prevention Pieces' Newsletter.

Part 3: EHHT Overviews

Environmental health, hazards, and threats are changing rapidly. This section summarizes EHHTs of importance to Marion and Polk Counties: wildfire, air quality and smoke, flooding, drought, extreme heat, power outages in the context of extreme weather, and changing vector patterns. Each EHHT section covers:

- The context and recent scope of the environmental threat in Marion and Polk Counties;
- Background knowledge of the threat and its impact on health using recent, high-quality academic or gray (government and high-quality philanthropy-funded) literature;
- Current knowledge of key populations at risk (see Table 14 for a summary); and
- Key recommendations, findings and needs based on emerging best practices.

Table 14. Populations at highest risk for each EHHT

Population at Risk	**Wildfire**	**Air Quality**	**Flooding**	**Water quality**	**Severe Storms**	**Drought**	**Extreme Heat**	**Power shut offs**	**Vectors**
People living in identified fire / flood zones	♦♦♦	♦	♦♦♦	♦♦	♦♦	♦	♦	♦♦	♦
People w/ underlying medical conditions	♦♦	♦♦♦	♦♦	♦♦♦	♦♦	♦♦	♦♦♦	♦♦♦	♦♦♦
People w/ intellectual or physical disabilities	♦♦♦	♦♦	♦♦♦	♦	♦♦♦	♦	♦♦	♦♦♦	♦♦
Outdoor workers	♦♦	♦♦♦	♦	♦♦	♦♦	♦♦♦	♦♦♦	♦	♦♦♦
Frontline workers (fire, EMT, police)	♦♦♦	♦♦	♦♦♦	♦	♦♦♦	♦	♦♦	♦♦	♦
Non-English Speakers	♦♦♦	♦♦	♦♦	♦♦	♦♦	♦	♦♦	♦♦	♦♦
Low-income communities	♦♦	♦♦	♦♦	♦♦	♦♦	♦♦♦	♦♦♦	♦♦	♦♦♦
Houseless communities	♦♦♦	♦♦♦	♦♦♦	♦♦♦	♦♦♦	♦♦	♦♦♦	♦	♦♦♦
Older adults	♦♦♦	♦♦♦	♦♦	♦♦♦	♦♦♦	♦♦	♦♦♦	♦♦♦	♦♦♦
Children	♦♦♦	♦♦♦	♦♦	♦♦♦	♦♦	♦♦	♦♦	♦♦♦	♦♦
♦= minimal additional risk; ♦♦=moderate elevated risk; ♦♦♦=high elevated risk									

Wildfire

Context and Scope of Wildfire Concerns

Wildfires have always been a part of the landscape. However, wildfires have increased in size and frequency in the past few decades, particularly in the western US. In September 2020, much of the Cascade Range was on fire. Also known as the Labor Day 2020 Wildfires, Marion County was directly impacted by most of the Beachie Creek Fire (131,596 total acres) and the western portion of the Lionshead Fire (204,586 total acres) (see Figure 13). Beachie Creek, ignited by lightning on August 16, grew significantly during the Labor Day windstorm that brought gusts of 75 mph. The fire damaged 720 structures in Marion County and another 193 structures on the Linn County side of the Santiam River. Several communities, including Mill City, Gates, Elkhorn, and the area around the Detroit reservoir – the primary water source for Salem – were severely impacted. Recovery in these communities is ongoing, with Marion County active in linking residents to resources, sponsoring a Health Impact Assessment and Economic and Opportunity Analysis, and participating in recovery planning efforts for Detroit and Gates.

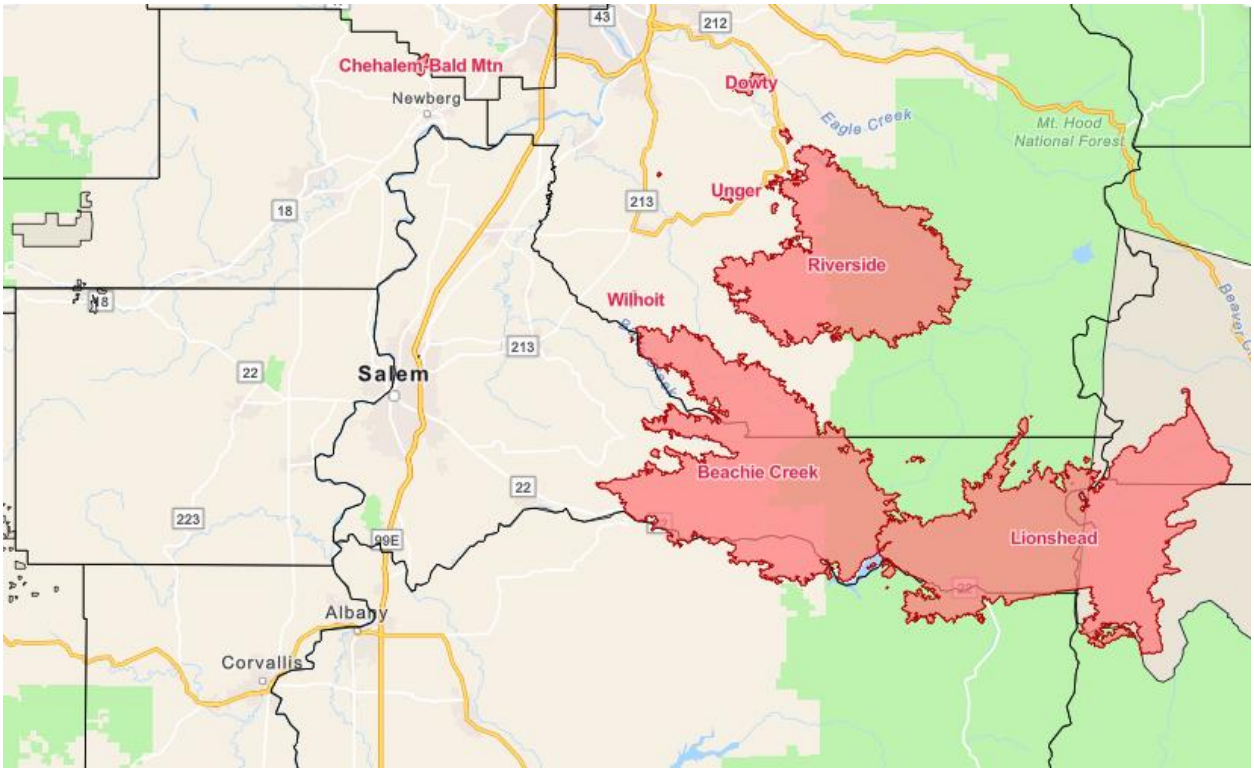


Figure 13. Burn perimeter of the Beachie Creek and Lionhead fires of 2020. Source: https://storymaps.arcgis.com/stories/6e1e42989d1b4beb809223d5430a375.

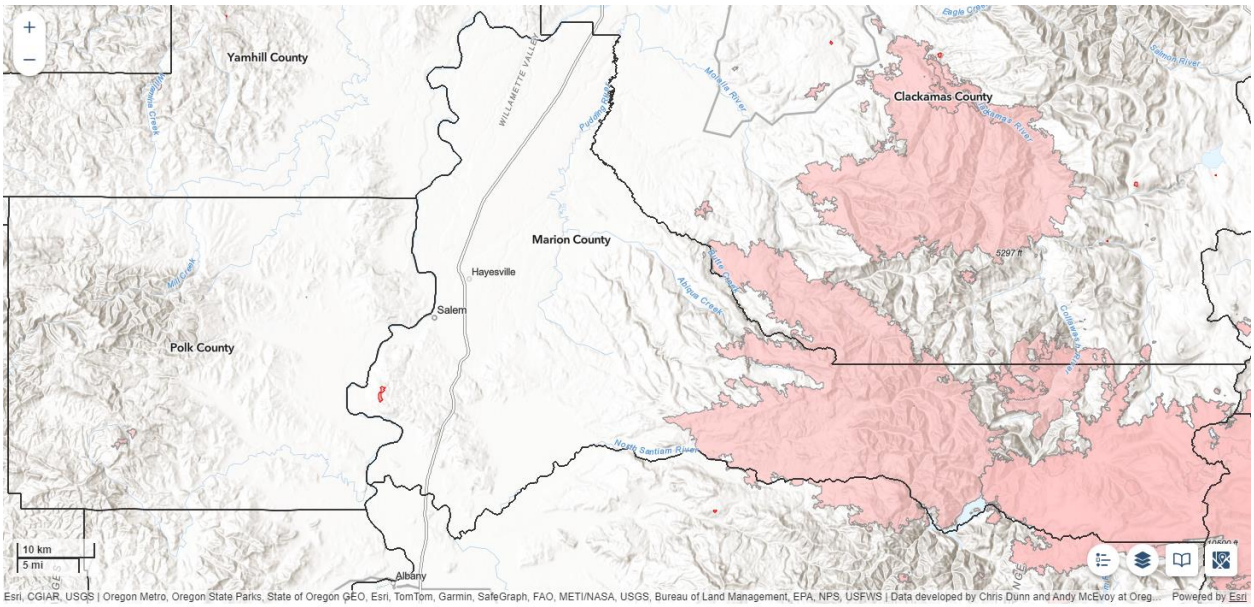


Figure 14. Wildfire areas through 2021 are in pink with 2022-2023 perimeters in dark red. Source National Interagency Fire Center.

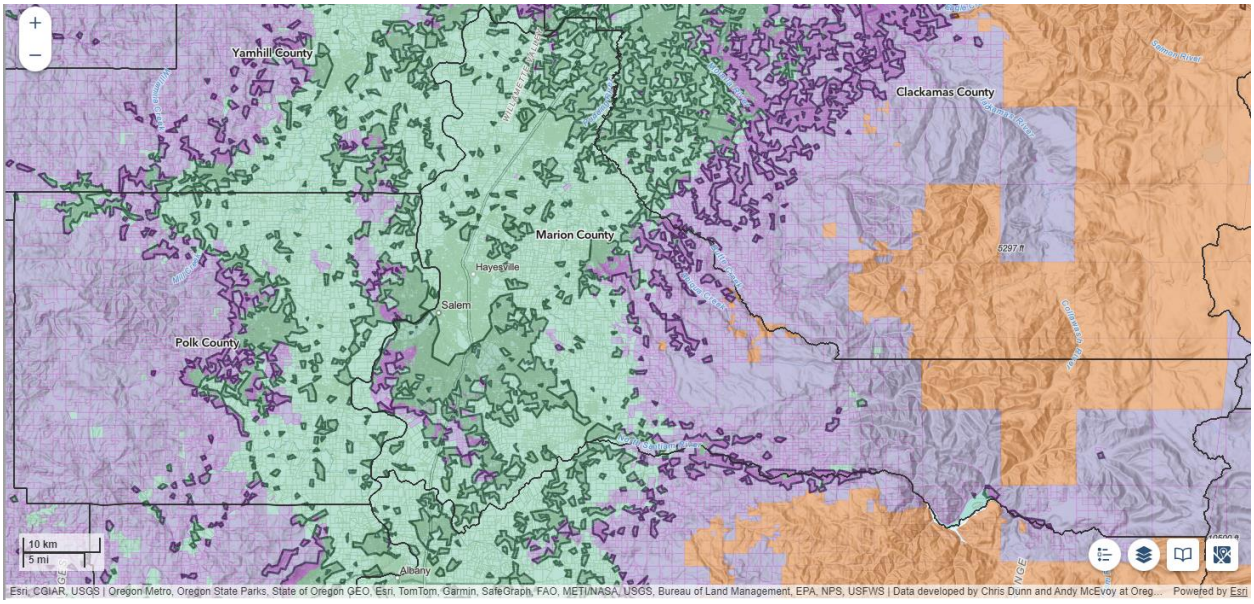


Figure 15. Wildland Urban Interface (WUI) defined areas on Overlaid on the Oregon Statewide Wildfire Hazard Map, 2024 DRAFT. Statewide Wildfire Hazard Map Website or the WUI technical brief

Wildfire threat is ongoing. Figure 14 shows historic fire areas in pink and augments the map with more recent wildfires from 2022 and 2023 in red. One of the region's primary wildfire prevention and management challenges is the extent to which populated areas in Marion and Polk Counties are adjacent to areas prone to wildfire. This is known as the wildland-urban interface or WUI. Figure 15 demonstrates this by overlaying WUI areas (darker shades) on top of the purple regions representing moderate wildfire hazard. These Statewide Wildfire Hazard Maps are updated regularly and play a significant role in targeting wildfire prevention efforts.

Public Health Impacts

The most egregious health impact is loss of life or injury from the wildfire itself. Preventing loss of life or property is the primary focus of the emergency management literature on predicting wildfires and implementing evacuation plans (Wong, 2020). The next most studied health issue from wildfires is exposure to smoke and its impact on respiratory, cardiovascular, and other conditions primarily seen in the fine particulate matter literature. (See Air Quality & Wildfire Smoke section below.)

Drawing on mental health literature from disasters more generally (Goldmann & Galea, 2014; Mao & Agyapong, 2021), scholars are starting to document wildfires' intense mental health impacts. If post-disaster rates of prevalence hold, post-traumatic stress disorder (PTSD) rates are likely 30-40% among those directly impacted, 10-20% of frontline

workers, and 5-10% in the general population (Nelson, 2020). There is additional evidence that over two-thirds of wildfire survivors have insomnia ten months out, and over one-third experience nightmares (Isaac et al., 2021). Lack of sleep may further complicate PTSD or other mental health challenges such as depressed mood and anxiety associated with disaster survival.

There is also a growing literature documenting poor pregnancy and birth outcomes associated with wildfires such as poor birth weight, early gestational age, respiratory assistance, and NICU admissions following birth (Evans et al., 2022). While the most obvious mechanism for these outcomes is increased maternal exposure to particulate matter from the smoke, the stress associated with wildfire events may also contribute to these adverse health outcomes (Evans et al., 2022).

Health Impacts on Vulnerable Groups

In addition to the focus on pregnancy and birth outcomes, there is a growing concern about the disproportionate impact wildfires have on specific populations (Afzal, 2021). Frontline workers such as firefighters (Koopmans et al., 2022) are the most studied, but there is growing attention to other outdoor workers, including migrant farm workers (Afzal, 2021). Studies have demonstrated that youth are particularly affected by wildfires and may show higher levels of mental health challenges after a wildfire (Adu et al., 2023). There are also concerns about the specific needs of older adults (Melton et al., 2023) and households with members with special medical or developmental needs (Hipper et al., 2018).

Recommendations, Needs, and Key Resources

Due to the technical nature of responding to fire, Emergency Management serves as the primary lead agency during wildfire events. However, public health has an important role to play in amplifying wildfire preparation messaging, meeting basic needs – including food, shelter, and medicine – when wildfires are active, and rebuilding resilience afterwards.

The leadership of Marion County in the aftermath of the Beachie Creek and Lionshead fires of 2020 is notable: linking residents to resources, sponsoring a Health Impact Assessment and Economic and Opportunity Analysis, and participating in recovery planning efforts for Detroit and Gates. The scale of these wildfires in 2020 are an opportunity for health surveillance to add to the existing literature and knowledge base on wildfire health impacts and longer-term recovery for both physical and mental health.

Air Quality & Wildfire Smoke

Context and scope of air quality concerns

Poor air quality is a major public health concern because poor air quality can lead to a wide range of health issues and disproportionately impact vulnerable groups. Federal National Ambient Air Quality Standards (NAAQs) require ongoing monitoring of six criteria pollutants (particulate matter, ozone, nitrogen oxides, sulfur oxides, carbon monoxide, and lead) to meet the Clean Air Act. Marion and Polk Counties are largely in attainment for these criteria pollutants. This historical exception has been carbon monoxide, typically attributed to cold weather stagnant air or inversion layer patterns that trap carbon monoxide and, in some regions particulate matter, in the valley. Carbon monoxide levels were brought into attainment through transportation emission standards and continued to demonstrate attainment through Oregon DEQs 2007-2017 maintenance plan.

Unfortunately, a changing climate is also putting pressure on several criteria pollutants on the West Coast, such as ozone during the summer (Rosser & Balmes, 2023). Rising pollen levels are also of concern (Barnes, 2018; Martikainen et al., 2023). This is particularly true in the Willamette Valley due to agriculture and lengthening growing seasons. A recent analysis of growing season length by Climate Central did not include Salem-Keizer but showed that the region's season has increased substantially, with an additional 26 days in Portland and 38 days in Eugene over the past 50 years.

However, wildfire smoke in late summer and early fall is the most concerning regional air quality hazard. Particulate matter (PM) is a major air pollutant that is a mixture of various chemical compositions with categories distinguished by particle size (Johnson et al., 2021; Patella et al., 2018). Exposure to $PM_{2.5}$ or smaller can be particularly harmful because the smaller diameter allows it to travel further into the lungs and even travel into the bloodstream (Johnson et al., 2021; Sampath et al., 2023). $PM_{2.5}$ is typically produced through combustion from sources such as vehicle emissions, power plants, industrial processes, and wildfires (Demain, 2018; Joshi et al., 2020; Wu et al., 2018).

In Marion and Polk Counties, like many places on the West Coast, wildfire smoke and accompanying health effects are increasing in frequency as the quantity and severity of wildfires release more $PM_{2.5}$ into the environment (Joshi et al., 2020; Wu et al., 2018). Before 2014, our region had never seen an "unsafe for sensitive groups" day due to smoke. Since then, wildfire smoke has been high enough to cause concern in six out of the ten years (Figure 16).

The 2020 Labor Day Wildfires included significant smoke impacts on the West Coast. Marion and Polk Counties were impacted by unusual wind patterns that pushed the smoke from the Cascade range into the valley (Figure 17). Conditions were hazardous across the region (Figure 18) with seven days of record-breaking hazardous air in Salem (Figure 16) and neighboring metro areas, including several days that were the worst in the world. Conditions were challenging enough in Lane County to the south that they were required to apply for an "Exceptional Event" waiver under NAAQS regulations.

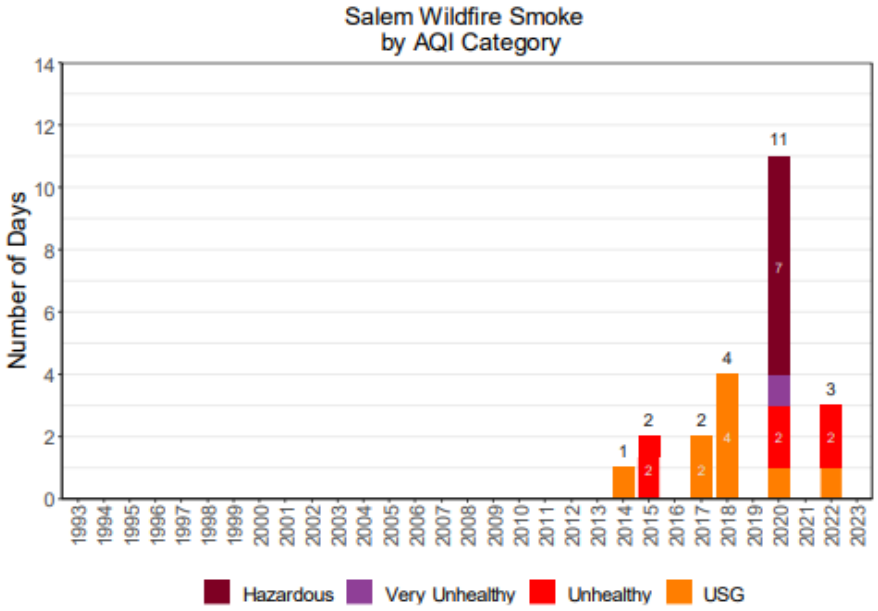


Figure 25. Salem wildfire ≥ USG AQI wildfire smoke trends.

Figure 16. Wildfire Smoke Trends in Salem. Source: Oregon DEQ https://www.oregon.gov/deq/wildfires/Documents/wf2024wfTrendsRep.pdf

Figure 17. NASA satellite imagery of wildfire smoke in Oregon 8 September 2020 demonstrating non-prevailing winds pushing smoke into the Willamette Valley. Source: [2020 Oregon Wildfire Spotlight]

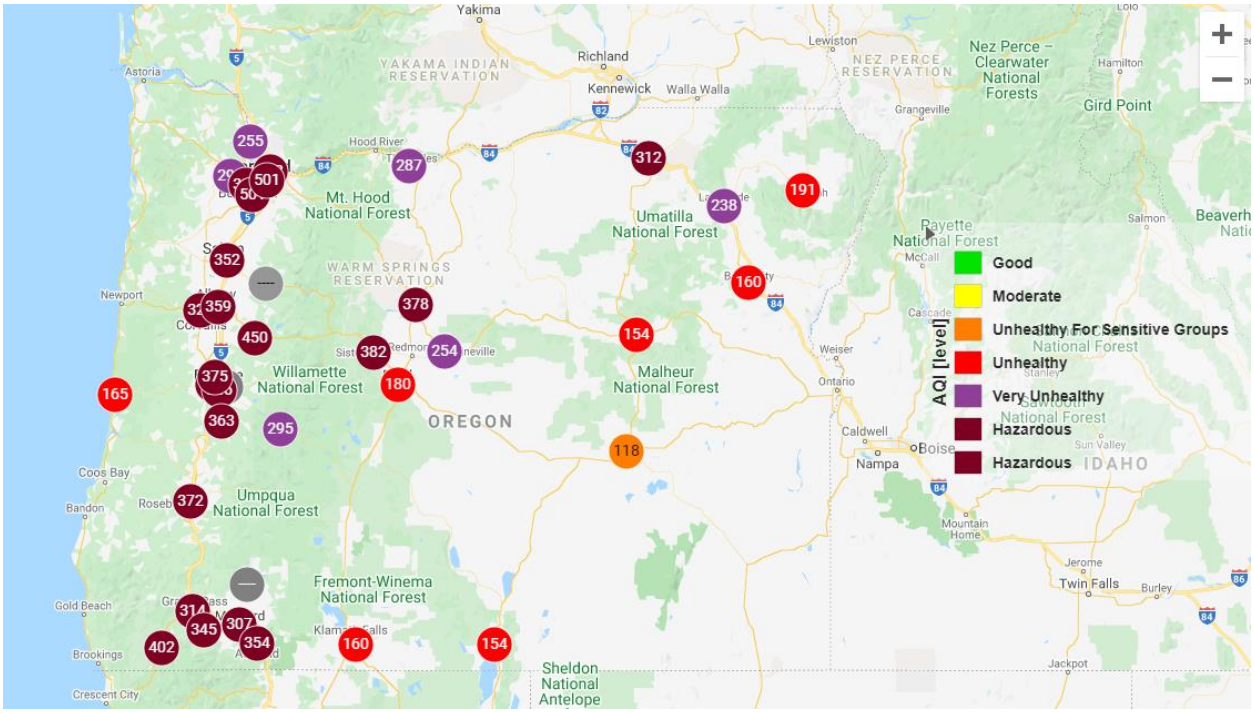


Figure 18. Air Quality readings in Oregon during the Labor Day 2020 Fires. Source: [2020 Oregon Wildfire Spotlight]

Areas east of the Cascades will continue to be hardest hit by wildfire smoke in the coming years due to drier conditions and prevailing winds. However, Marion and Polk Counties must be prepared for fires on the western flank of the Cascade Range, anywhere on the Coastal Range, and unusual wind patterns that can transport wildfire smoke from eastern Oregon over the Cascades and into the Willamette Valley.

Public Health Impacts

Exposure to particulate matter, pollen, ozone, and mold can worsen preexisting health conditions or lead to future health issues. Research has primarily focused on respiratory for pollen and cardiovascular disease of both PM and ozone (Barnes, 2018; Demain, 2018; Deng et al., 2020; Joshi et al., 2020; Patella et al., 2018; Tran et al., 2023). Pollen season is correlated with developing and exacerbating respiratory diseases such as asthma and allergic rhinitis (Choi et al., 2021).

Wildfire smoke and $PM_{2.5}$ have been associated with poor respiratory health outcomes and may worsen symptoms of asthma and chronic obstructive pulmonary disease (COPD) (Gould et al., 2024; Joshi et al., 2020; Noah et al., 2023; Wu et al., 2018). For example, smoke "event" days in California have been associated with a 3.3% increase in emergency department visits for respiratory events generally and a 10% increase for asthma, specifically on a one-day lag (Heaney et al., 2022). Exposure to $PM_{2.5}$ has also been shown to increase cardiovascular disease and events such as heart attacks and strokes, increase risk of reduced birth weight, reduce mental health, and cause cancer (Alemayehu et al., 2020; Eisenman & Galway, 2022; Gould et al., 2024; Grant & Runkle, 2022; Johnson et al., 2021; Steinle et al., 2020; Trombley, 2023; Wu et al., 2018).

Health Impacts on Vulnerable Groups

Certain groups are more vulnerable to the effects of wildfire smoke, poor outdoor air quality, and increased pollen. Firefighters, unhoused, and outdoor workers are more likely to be exposed to poor air quality including wildfire smoke, even as these populations have been understudied (Gould et al., 2024; Navarro, 2020). Low-income households are less likely to live in the wildland-urban interface (WUI) and thus at lower spatial risk of wildfire (Gabbe et al., 2020). However, analysis suggests that communities of color, limited English, and crowded housing have seen increased exposure to wildfire smoke (Vargo et al., 2023). They are more likely to live in substandard housing without an HVAC system that can filter the air, a primary mitigation strategy for most populations (Liang et al., 2021; Romitti et al., 2022). Similarly, most older school buildings do not have appropriate HVAC

systems, drastically increasing school children's exposure to smoke in the fall and pollen in the spring (Holm et al., 2021).

Certain individuals across the life course are also more impacted by poor air quality (Wu et al., 2018).

- For example, children under six years of age showed the strongest effect size of asthma emergency department visits after a smoke event day (Heaney et al., 2022). Another meta-analysis demonstrated a statistically significant 13% increase in upper respiratory infection in children and adolescents and a 21.71 gram reduced birth weight for every 10 $\mu g/m^3$ from wildfire-specific $PM_{2.5}$ (Zhang et al., 2024).
- Older adults are more likely than any other group to have increased cardiovascular events when exposed to wildfire smoke (Heaney et al., 2022) which may be due to physiological differences and higher prevalence of preexisting conditions. Respiratory impacts are documented among older adults during wildfire smoke days with women (10.4% higher vs 3.7% for men) and blacks (21.7%) at highest risk (J. C. Liu et al., 2017).

Finally, there is a growing concern that vulnerable populations, particularly older adults, are challenged by the combination of wildfire smoke and heat (Coker et al., 2024; Rosenthal et al., 2022).

Recommendations, Needs, and Key Resources

Public health can play a critical role in preventive behavior during poor air quality events, but intersectoral collaboration is needed to predict and prevent these events at scale. Examples of this include:

- Assistance of meteorology for almost all types of air quality events;
- Coordination with the agriculture sector to predict high pollen season;
- Tight coordination with emergency management to forecast wildfire activity increases the amount of time households can use to source supplies such as filters and masks and implement health-protective behaviors such as staying indoors (Gould et al., 2024);
- Collaboration with schools to increase access to filtered air during wildfire season in the fall and pollen season in the spring (Holm et al., 2021).

Air quality is a spatially diffuse hazard that requires broad communication strategies. In addition to the resources found in the wildfire section, notable government resources include:

- CDC's How Wildfire Smoke Affects Your Body and Safety Guidelines.

- EPA's Air Quality Index at www.Airnow.gov is now integrated into most mobile phone weather apps.
    - There is now a fire-specific version found at www.fire.airnow.gov.
    - Year-round communication of the AQI index can increase familiarity with wildfire events while improving preparedness for other PM and ozone events.
- Oregon DEQ manages a smoke-specific website at www.oregonsmoke.org which links to Oregon Health Authority information on smoke and health.

Air quality must also account for other social vulnerabilities such as lack of HVAC and/or outdoor work. In general, despite the near-universal acknowledgment that vulnerable populations should be prioritized in communication, messaging specific to vulnerable populations is limited and needs to be improved (Van Deventer et al., 2021; Vien et al., 2024).

A recent review of wildfire smoke risk communications suggests gaps in knowledge about personal (masks) and whole-room air filtration strategies (Vien et al., 2024). This excellent summary of all recent wildfire smoke risk communication academic literature suggests communication strategies should:

- Include clear, direct, and simple language that offers timely and practical advice that balances common sense recommendations (spending less time outdoors) with technical information (running an air filter if you have one).
- Communicate air quality readings, wildfire locations, and wind readings, usually on a well-designed map with short text.
- Leverage traditional (television, radio, and print) and newer digital media, including well-designed and accurate mobile phone apps (Vien et al., 2024).

Finally, government messaging should be refined to communicate effective interventions. An analysis of messaging during the 2018 wildfire smoke season in Washington state suggested that only 46 percent of government messaging contained a concrete personal intervention for risk reduction, only 37 had building or administrative intervention suggestions, and only 28 percent contained information about vulnerable populations (Van Deventer et al., 2021).

Communication strategies should also increasingly incorporate the co-exposure of wildfire smoke and heat (Coker et al., 2024; Rosenthal et al., 2022).

Flooding

Context and Scope of Flooding Concerns

Marion and Polk counties both have a history of large flood events. The construction of dams throughout the region has lessened the impacts of these floods in more populated areas, but floods remain a concern. The 2012 flood caused $11.2 million in damage to Marion County and damaged over 200 buildings in Salem. Other notable flood events include the 1996 floods and the Christmas flood of 1964 – both of which prompted evacuation, caused significant damages, and resulted in deaths. The First Street Flood Model estimates that 20.3% of properties in Marion County and 17.7% of properties in Polk County are at risk of flooding within the next 30 years.

The Mill Creek floods State Street on Thursday, Jan.19, 2012.
Statesman Journal File

Sightseers flock to the bridge, just south of Independence to see the high water during the 1996 flood.
Statesman Journal File

Figure 19 Flooding at State Street in Jan 2012 (left) and Willamette at Independence in 1996 (right). Source: Statesman Journal

Public Health Impacts

Catastrophic flooding has numerous consequences that can impact social well-being, mental health, and economies (Venkataramanan et al., 2019). Health impacts may be "immediate" (i.e. trauma, hypothermia, electrocution), "early" - occurring within 10 days (i.e. skin infections and viral and aspiration-related respiratory conditions), and "late" - onset later than 10 days (ie. mosquito-borne disease, PTSD, and some viral and fungal infections) (Paterson et al., 2018). Flooding can disrupt access to healthcare for those needing chronic and acute care, and strain healthcare infrastructure (Paterson et al., 2018). It is also associated with gastrointestinal diseases (Andrade et al., 2018; Exum et al., 2018; Paterson et al., 2018) due to compromised sewage systems releasing untreated effluent into nearby water sources (Bell et al., 2018). Flash flooding can move pathogens into surface water via runoff and into groundwater sources (Andrade et al., 2018).

Health Impacts on Vulnerable Groups

During flood events, women, older adults, and children are more vulnerable to negative health impacts, while the mortality risk was highest for males between ages 10-29 (Lowe et al., 2013). First Responders and workers responsible for flood cleanup also face higher risks. Post-flood consequences were higher for groups such as older adults, those with underlying medical conditions (who may have had access to medications and/or care disrupted), renters, and those who were uninsured or underinsured (Lowe et al. 2013; see paper for full list).

Flooding also presents significant challenges for the unhoused who may have encampments in flood zones. This population may experience direct consequences from flood waters and exposure to chemicals or infectious agents in the water (Parker et al., 2022). One study of the 2015-16 Shigella outbreak in Oregon found that nearly half (43%) of identified infections occurred in unhoused individuals, and in this population was linked to heavy precipitation (Hines et al., 2018). The proposed pathways for this association are multiple, including the impact of heavy rain events on sanitation, compromised drinking water, and increased congregation (Hines et al., 2018). Flooding can also result in temporary or permanent displacement, acting as a driver of houselessness (Bezgrebelna et al., 2021). This can include children. Long-term displacement of K-12 students presents a number of communication and learning challenges for children, such as was the case in the town of Lumberton, NC following flooding associated with Hurricanes Matthew and Florence, and were felt most acutely in lower-income areas (Mazumder et al., 2023).

Recommendations, Needs, and Key Resources

The US Department of Housing and Urban Development's HUD Exchange has a Disaster Recovery Homelessness Toolkit, which contains three guides. These are not specific to flooding and are useful to a range of EHHTs

- Local Planning Guide: Addressing people experiencing homelessness in disaster planning effort
- Response Guide: Meeting the needs of people experiencing homelessness during disaster response
- Recovery Guide: Meeting the needs of people experiencing homelessness during disaster recovery

Vickery's 2018 dissertation explored the impacts of the 2013 Colorado floods on the unhoused in Boulder County. The end of the dissertation contains recommendations that result from interviews with unhoused individuals and organizations that serve the unhoused:

- Pre-existing relationships and familiarity between responders and unhoused are important, including "gatekeepers" who may know where to find harder-to-reach individuals.
- Phone-based emergency alerts are useful, but should be supplemented by posted updates to date announcements in known physical locations where the unhoused community regularly gathers.
- Leniency following disasters (regarding citation) is important given the physical loss of property and campsites.
- Staff may be unable to reach emergency shelters during flooding events. In this case, having an "emergency volunteer roster" of already trained individuals may be helpful.
- Plans specifying operations, roles, and communication channels among agencies and organizations should be crafted in advance, including through MOUs (Vickery, 2017)

Risk communication of floods continues to be challenging, even in the internet and social media age. Social-media can help with immediate communication needs, but it likely needs to be paired with wider, appealing, and longer-term engagement for decision making (Mostafiz et al., 2022). Maintaining and utilizing online flood risk web resources can be one way to build longer-term risk communication with communities (see Table 1 in (Mostafiz et al., 2022)). Other research suggests that more needs to be done to help individuals bridge their understanding of household flood risk versus community flood risk (Lazzarin et al., 2024). While traditional flood hazard maps will likely remain the gold standard, several articles suggest that a diversity of maps and visual information that is human centric is the easiest for communities to engage (Lazzarin et al., 2024; Skilton et al., 2022).

Water Quality

Context and Scope of Water Quality Concerns

Key water quality concerns in Marion and Polk Counties include infectious agents, fertilizers, pesticides, heavy metals, toxic substances, sediment, and water temperatures. Many of these concerns are coupled with EHHTs discussed elsewhere in this report. For example, flooding events increase exposures to water related pathogens and contaminants (Andrade et al., 2018), drought and human-induced water scarcity can increase the concentration of nutrients, pollutants, and pathogens in water, while wildfires can result in an increase of metals and nutrients entering into local water systems (Mishra et al., 2021; Oregon Health Authority, 2021). The Community Health Impact Assessment of the Santiam Canyon highlights the coupled concerns of wildfire and water quality in multiple ways. Concerns about drinking water quality and access following the Labor Day Fires were notable among participants, with over half of participants (54%) reporting that they lacked access in the year following the fire. As the report highlights, the reasons are

multiple: the infrastructure to treat and distribute water in the city of Detroit was damaged by the fires and ultimately offline for 7 months. The presence of VOCs in the water following the fires resulted in a lack of water in the city of Gates for 3 days. The situation for private well owners is less clear due to lack of regulation (Braverman, 2021).

High temperatures can contribute to an increase in infectious agents and harmful algae blooms (Igwaran et al., 2024) found in bodies of freshwater. Other environmental factors associated with harmful algal blooms include eutrophication due to excess nutrients, notably nitrogen and phosphorus, human actions, weather and hydrological variability, and microbial adaptation (Igwaran et al., 2024). Past harmful algal bloom advisories were issued in Marion County for Detroit Lake in 2007, 2015, 2017, 2018 (OHA HAB Advisory Archive). At the time of this report, an active HAB advisory has been in place in Marion County since July 16, 2024 for the North Santiam River, along with the Detroit and Big Cliff Reservoirs. Unlike the 2018 advisory, the current advisory does not extend to drinking water, as test results demonstrate that the new ozone treatment and upgraded sand filtration have been effective in removing detected cyanotoxins.

Mercury, arsenic, pesticides, and other pollutants are also a concern in our region. Data from the Oregon Domestic Well Testing map shows that 17% of wells in Marion county tested had arsenic levels above 10ppb. Zero percent of wells tested in Polk County had arsenic detected at these levels, but there was limited data available for this county. A model-based study, conducted by researchers with the USGS and CDC, estimated that 500-5,000 domestic well users in Marion and Polk Counties may have arsenic levels over 10 µg/L (Ayotte et al., 2017). The revised Mercury TMDL for the Willamette basin sets aggressive reductions in Mercury targets to reduce mercury from entering water bodies by 2048. The ODWT map also shows 2.3% of wells in Marion County and 1.69% in Polk County have nitrate levels over 10ppm.

Public Health Impacts

Harmful algal blooms pose a concern to both recreational and drinking water supplies. Exposure to cytotoxins can result in symptoms such as skin and respiratory irritation, headache, GI upset, neurological impacts, the immune system and liver damage, depending upon the route of exposure (Ho & Goethals, 2019; Igwaran et al., 2024; Perkins & Trimmier, 2017) which can also be reviewed at both the CDC and the U.S. National Office for HAB. Such exposures can result in both short-term and long-term health impacts (see Igwaran et al. 2024, Table 2). Mycrocystins, one of two types of toxins identified with the 2018 Algal Bloom at Detroit Lake (Dreher et al., 2022), is a known liver toxin, Research

using remotely sensed imagery of cyanotoxin blooms across the US found an association between the presence of blooms and higher rates of non-alcoholic liver disease at the county scale (Zhang et al., 2024). HABs can also impact domestic well water in Oregon. Public health impacts of other common contaminants in local wells are shown in Figure 20.

Common Contaminants in Oregon Wells:

Contaminant	Health Problems	Sources or Causes
Arsenic	Cancer, heart disease, stroke	Naturally occurring
Nitrates	Miscarriages, birth defects, thyroid disorders, gastric or bladder cancer and methemoglobinemia (or "blue baby syndrome")	Septic systems, agricultural fertilizers, livestock waste
Fecal bacteria	Diarrhea and vomiting (some E. coli strains can be deadly)	Septic systems, livestock waste, improperly constructed or maintained wells

Figure 20. Common Contaminants in Oregon Wells Source: Contaminated Drinking Water - Oregon Environmental Council.

Infectious agents found in surface water are also a concern for recreational swimmers, and may cause GI, respiratory, or skin conditions (Perkins & Trimmier, 2017). Cases of *Cryptosporidium* and *Giardia,* for example, peak in summer predominantly because they are linked to treated recreational waters - such as pools or hot tubs - as the most common source of exposure (Ma et al., 2022; Perkins & Trimmier, 2017). Work understanding how environmental variables impact transmission in untreated bodies of water, such as lakes and rivers, remains ongoing. As with most infectious diseases, the relationships are complex. Temperature may favor survival of these pathogens, and lower water levels may concentrate them; other environmental factors include vegetation cover, precipitation patterns, and soil and water conditions (Wang et al., 2023).

Heath Impacts on Vulnerable Groups

In the case of HABs, it is known that specific groups are most vulnerable, as was effectively communicated during the 2018 case in Salem. These include young children and older adults, those with existing kidney and liver diseases, pregnant or nursing persons, and anyone immunocompromised. Children may be more at risk to contracting other water-

borne illnesses as well, such as was the case in the norovirus outbreak at Blue Lake in Multnomah County for multiple reasons, including susceptibility to the virus, time spent in more shallow areas, and the tendency to ingest more water. Other groups impacted by these events include individuals and communities that depend on recreation income. These economies can be significantly impacted by water and beach closures, such as those resulting from HABs, *E. coli* (Wolf et al., 2019).

Well users in rural populations are also at more risk, as outlined in the drought section. Infants are known to be particularly vulnerable to the impacts of nitrate. Renters who may not have access to well water testing results from their landlords, or low income households who struggle to afford the cost of testing, are also more vulnerable, and thus why legislation such as HB 2404, which would have required landlords who rent properties with well water to test and report results to tenants if it had passed, is important.

Recommendations, Needs, and Key Resources

A recent study looked at key water security interventions from across the United States and considered their application potential to Oregon. Interventions are applicable to water quantity concerns, in addition to quality. They list four recommendations for public health agencies (and others) working in this area, with additional specifics related to intervention scale, feasibility, and relevance to the Oregon context documented in Table 3.

- Understand spatial and community variation in access to safe drinking water.
- Understand experiences faced by water-insecure households and individuals.
- Improve mapping and monitoring of water scarcity.
- Work with a range of partners to move Oregon towards a “Human Right to Water” state policy, following California's lead.

Drought

Context and Scope of Drought

Drought conditions regularly occur in Marion and Polk Counties despite high annual precipitation. Figure 21 shows the percentage of each county that has experienced drought conditions and their severity since 2000. These conditions have been especially notable in the past decade, with severe and extreme drought conditions occurring in 2015 and over the past five years. Drought persisted through most of 2023, peaking in early fall, when about 20% of Marion County and 30% of Polk County experienced severe drought

conditions. Regional projections predict more frequent and severe droughts in the coming decades, which also increase wildfire risk (Chang et al. 2023).

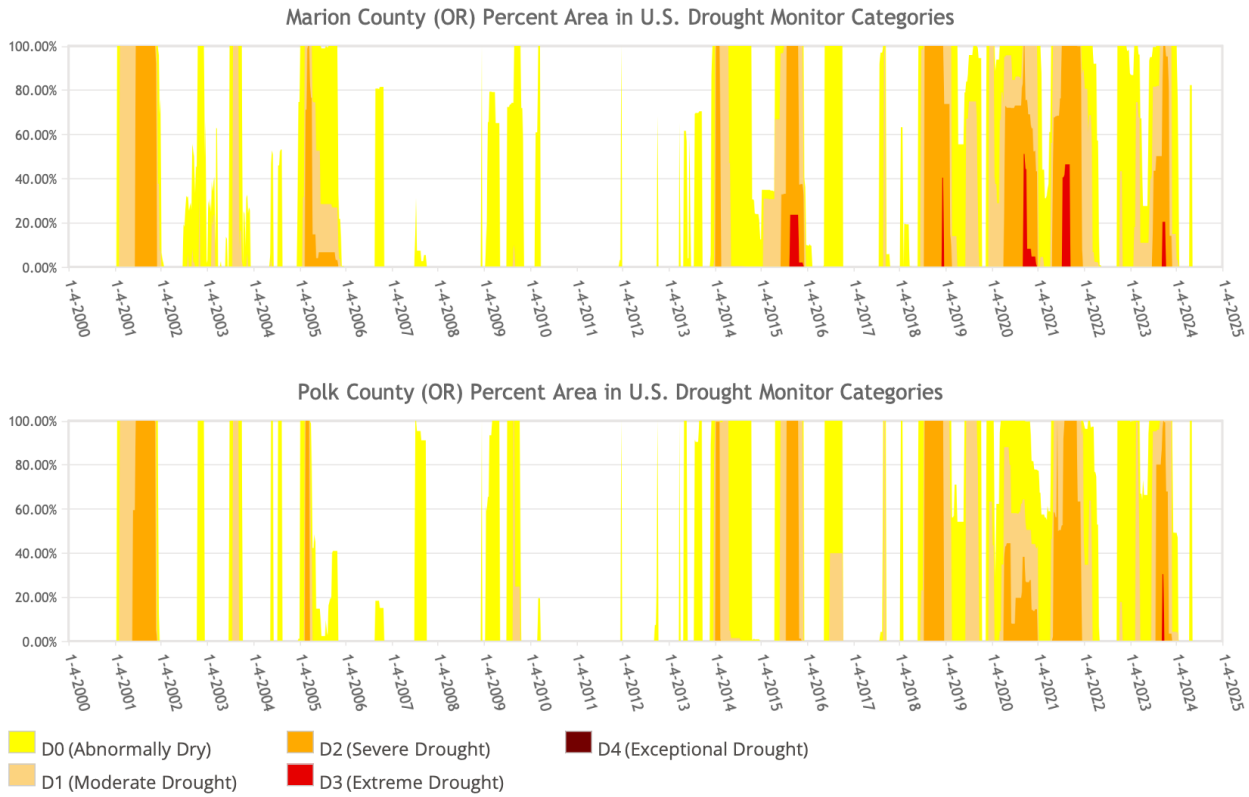


Figure 21. Drought conditions in Marion and Polk Counties. Source: U.S. Drought Monitor website, https://droughtmonitor.unl/edu/DmData/Timeseries.aspx, 6/20/2024

Public Health Impacts

Drought conditions impact health in numerous direct and indirect ways. They can severely affect water security and quality by reducing freshwater flow, increasing contaminant concentrations, and providing more favorable conditions for water-borne pathogens (Bell et al., 2018; Krawisz, 2020; T. Liu et al., 2020; McDermott-Levy et al., 2021; Salvador et al., 2023). In some instances, reduced surface water can limit mosquito-breeding habitats, but in others, stagnant water conditions and changes to water storage practices may prove favorable to some mosquito species (Bell et al., 2018; M. D. Khan et al., 2019; T. Liu et al., 2020; Salvador et al., 2023). Droughts have been linked to increased airborne dust, which impacts cardiovascular and respiratory health through heightened levels of particulate matter, allergens, or exposure to soil-borne pathogens (Berman et al., 2017; T. Liu et al., 2020; Salvador et al., 2023). Droughts may also cause or exacerbate mental health issues, particularly among farmers and rural communities, whose livelihoods are dependent upon reliable quantities of water (Berman et al., 2021; T. Liu et al., 2020; Wlostowski et al., 2022; Woodland et al., 2023). Ultimately, the stress of worrying about the consequences of not

having enough water to sustain livelihoods and/or local economies may have physiological and psychological impacts (McDermott-Levy et al., 2021).

Health Impacts on Vulnerable Groups

Rural communities are particularly vulnerable to the direct and indirect consequences of drought. This is both due to the reliance of livelihoods on adequate water, as well as reliance on private wells which may go dry during extended drought periods. Wells are often located in areas with a higher density of septic tanks, which have been linked to increases in E. coli contamination (O'Dwyer et al., 2021). Other potential contaminants include pesticides, volatile organic compounds (VOCs), and harmful bacteria (Fizer et al., 2018), and as with surface water conditions, may be negatively impacted during drought. These issues are exacerbated by the fact that private wells are managed by property owners, with typically few requirements for well water testing. Moreover, droughts have a particularly strong impact on rural infrastructure and water systems, which often struggle to cope with drought conditions due to aging infrastructure and limited safety measures (Schimpf & Cude, 2020). The socioeconomic impacts of drought are also acutely felt in communities that rely on environmental tourism and recreation, and those dependent upon agriculture, ranching, or forestry (T. Liu et al., 2020; Wlostowski et al., 2022). In addition to the broader mental health consequences described above, Adolescents in these communities may experience significant mental health impacts as they are affected by community and family-level stress (Dean & Stain, 2010).

Recommendations, Needs, and Key Resources

Reports by the CDC's National Center for Environmental Health (NCEH) and the National Integrated Drought Information System (NIDIS) both recognize the coupled relationships between drought and health, and the need to increase integration across the drought and public health sectors.

- CDC's When every drop counts; protecting public health during drought conditions--a guide for public health professionals (2010) gives a comprehensive overview of drought and health connections, public health drought preparedness and response activities, vulnerability assessments, needs, and communication strategies. Appendix A of this CDC publication includes communication objectives by target audiences, which may be particularly useful.
- NIDIS' Drought and Public Health: A Roadmap for Advancing Engagement and Preparedness (2023) includes recommendations in four areas to support health during drought events. A few key specific recommendations from each area are included below
    - Partnership and collaboration:

        - Include public health representation at drought meetings and vice-a-versa.
        - Add drought impact questions to community health needs assessments.
    - Communication and outreach:
        - Communicate to vulnerable populations through tailored materials.
        - Collaborate with Agricultural Extension offices to reach rural communities at higher risk of drought impacts.
    - Interdisciplinary research and application:
        - Examine past drought events in the region to understand needs and impacts.
        - Improve understanding of drought impacts on private wells.
    - Planning and preparedness:
        - Ensure health impacts are included in drought assessments and reports.
        - Use tabletop exercises to anticipate health impacts and needs during drought.
- NIDIS' Drought and Health: A Messaging Framework for Public Health Professionals & Healthcare Providers (2024) includes information on key partners, messaging guidelines, messaging maps that correspond with drought severity, and examples of communication statements.

A recent Oregon-wide report on agricultural producer stress found that 35% of Oregon farmers surveyed reported feeling stress related to weather (notably drought and wind) "fairly often" or "very often" during the past year. OSU Extension Service also released Beating the Heat: A Statewide Assessment of Drought and Heat Mitigation Practices (and Needs) with Oregon Farmers and Ranchers in 2023 to document challenges. Several resources exist to support agricultural communities that feel the burdens of drought most intensely in our areas:

- The Clearinghouse Archive - Western Region Agricultural Stress Assistance Program maintains a searchable database by topic and state for specific resources. Example categories include: Farm Stress, Disaster Relief, Funding Opportunities, and Resources for specific groups (BIPOC, Disabled, LGBTQIA, Tribal, Veteran, Women Farmers, and Farmworkers).
- OSU's Farm and Ranch Stress Assistance Network includes resources to support resilience
- The AgriStress Helpline is available 24/7 to support farmers, fishers, and foresters experiencing chronic or acute stress

Severe Winter Storms

Context and Scope of Winter Storm Concerns

Marion and Polk Counties, due to latitude and covering the area between the Coast Range and Cascade Range, are at relatively high risk of wintery-mix storms. Wintery mix storms, defined as ice storms when freezing rain accumulates over 0.25 inches, are generally more disruptive with a greater likelihood of power outages and property damage (Degelia et al., 2016). A changing climate increases the likelihood of intense winter storms and the Pacific Northwest is positioned to see wetter and more intense winter precipitation as atmospheric rivers and large arctic masses collide over the region (Chen et al., 2023). In Marion and Polk Counties, this is likely to take the form of increased ice storms on the valley floor.

The most damaging ice storm since 1980 began Feb 11, 2021. This storm illustrates the scope and severity of winter storms that will likely become more common. The Oregon Office of Emergency Management (OEM) has a 2021 February Winter Storm Spotlight Storymap that documents the set up and extent of the damage. The cold air mass resulted in nearly an inch of ice accumulation in the mid-Willamette Valley, making roads throughout the region nearly impossible. This ice accumulation snapped trees and power lines, resulting in nearly half of PGE's customer base in Oregon experiencing a power outage. Marion and Polk Counties were hit particularly hard by power outages with over 83 thousand households or workplaces without power (see Figure 22). Due to the massive area affected and the lingering cold, 55 thousand were still without power six days into the storm and 10 thousand without power over ten days after the beginning of the storm. In some communities, such as Scotts Mills, a significant number of households were without power for two weeks. In other words, the ice storm quickly became a power outage hazard as households were stuck at home without heat, refrigeration, internet, communication, and in some cases, a working water system (2021 February Winter Storm Spotlight).

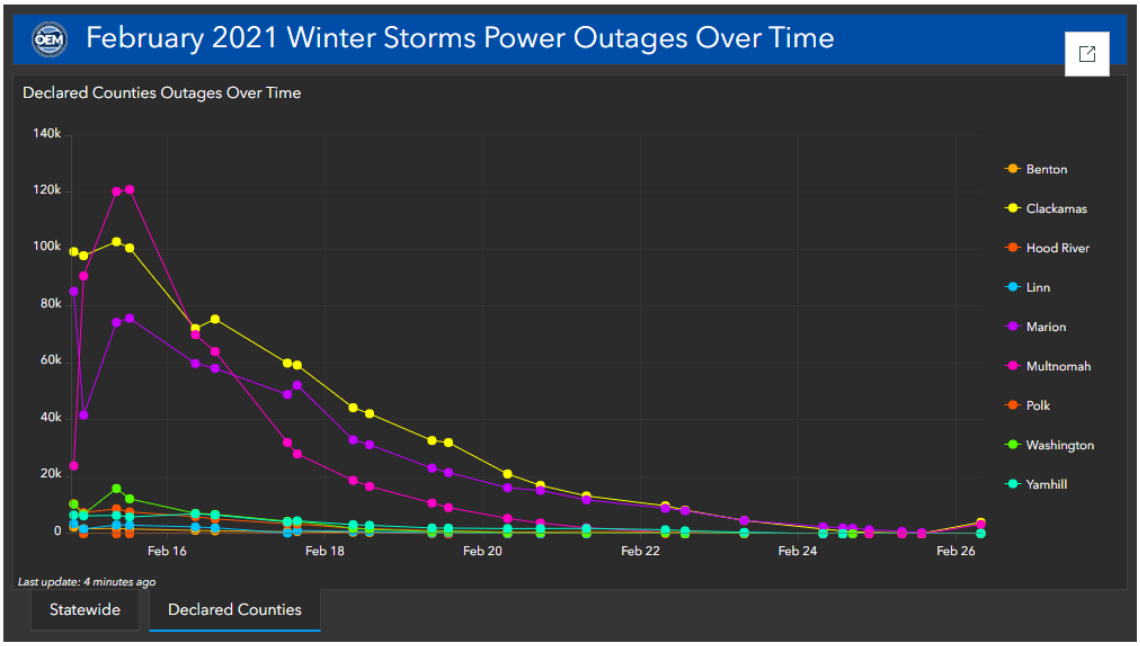


Figure 22. Power outages over time for Counties affected by the February 2021 Winter Storm. Marion (purple) and Polk (orange) Counties were particularly hard hit. Source: Oregon OEM 2021 February Winter Storm Spotlight.

Cleaning up the 2021 Ice Storm illustrates the scale of the destruction. The City of Salem removed over 78,000 cubic yards of debris from public right of ways; Marion County reported another 70,000 cubic yards. Utilities had to replace miles of line and hundreds of power poles. After several months of local and state agencies attempts to clean up after the storm, FEMA declared a federal disaster on May 6th so that federal funds could supplement the significant costs accrued by local governments (2021 February Winter Storm Spotlight).

Public Health Impacts

Winter storms are challenging to public health. Exposure to the cold can result in frostbite and hypothermia (Haney, 2020). Injuries from pedestrian falls and traffic crashes increase significantly in winter weather (Degelia et al., 2016) with falls during ice storms doubling (Mills et al., 2020). Social isolation can contribute to poor health impacts (Haney, 2020). Power loss can exacerbate the situation, resulting in adverse health impacts (Degelia et al., 2016; Lin et al., 2021) including carbon monoxide poisoning from seeking alternative and higher risk sources of heat, particularly around children (Andresen et al., 2023; Casey et al., 2020).

A recent review of deaths from Winter Storm Uri in February 2021 in Texas using surveillance data documented 136 deaths, giving a sense of the common adverse health

pathways: 47 percent were from temperature exposure, 12.5 percent from motor vehicle crashes, and 7.4 percent from carbon monoxide poisoning (Hanchey et al., 2023).

An assessment of New York State hospitalizations between 2001 and 2013 provides solid surveillance estimates for acute physical health impacts immediately following a winter storm (Lin et al., 2021). The study groups hospital admissions by cardiovascular disease, lower respiratory disease, respiratory infection, food-borne illnesses, and injury; differentiated between ice and snow storms; and also accounted for power loss. Highlights included:

- Ice-storms (RR: 1.04-3.15) have a stronger impact than snow storms (RR: 1.03-2.21);
- The joint effect of power-loss and storm (RR 1.01-1.90) is greater than storm alone (RR: 1.02-1.39);
- Lags of up to a week are evident for many hospitalization categories (Lin et al., 2021).

Health Impacts on Vulnerable Groups

In general, disproportionate impacts of winter storms have focused on life course issues (very young and old), preexisting conditions, and socioeconomic vulnerabilities. As an example of a life course issue, older adults are disproportionately at risk of falls, so slippery conditions associated with winter storms generally is thought to increase falls disproportionately in that group (Haney, 2020; Kakara et al., 2021). Similarly, the very young and very old have a more difficult time regulating temperature in extremely cold settings. There also may be certain preexisting conditions and/or medications that increase risk of poor temperature regulation (Haney, 2020).

Additional socioeconomic conditions also make it more likely that individuals will be exposed to difficult conditions in winter storms or do not have access to resources to prepare for or buffer through the situation (Haney, 2020; Portillo et al., 2024). An example of this might be that individuals with pre-existing conditions, especially those who need daily medication, may not be able to pay out-of-pocket to prefill life-saving prescriptions (Robles-Lopez et al., 2023).

The 2021 Winter Storm Uri that hit Texas, resulting in prolonged icy conditions and power outages, is being extensively studied. While Uri was a specific context, many of the social vulnerabilities documented are likely to occur elsewhere. Examples include:

- Patients presenting with carbon monoxide poisoning during Uri were more likely to come from neighborhoods with a higher CDC Social Vulnerability Index (Portillo et al., 2024).
- A recent investigation of mental health six months after found those living with disability or having a major adverse event reported increased odds of depression and anxiety. Minority status was associated with greater odds of depression (Grineski et al., 2023).
- Low-income households were less likely to adequately characterize hazards and were more likely to perceive costs of preparing for a storm as too high (Li et al., 2023).
- Financial concerns due to missed work and/or spoiling food can contribute to stress in winter storms, particularly for lower income households (Soleimani et al., 2023).

Recommendations, Needs, and Ley resources

The CDC maintains a good website for winter storms that includes:

- A checklist of ways to prepare for and manage through winter storms including ways to safely heat and light a home without electricity;
- A specific sections on keeping infants and older adults who may struggle to maintain their body temperature;
- Ways to be safe outdoors and while traveling; and
- Signs of frostbite and hypothermia.

The American Red Cross maintains checklists and factsheets including a power outage sheet and winter storm safety in many languages.

Power Shutoffs

Context and Scope of Power Shutoff Concerns

Power outages due to extreme weather events are anticipated to become more frequent and severe (Andresen et al., 2023; Casey et al., 2020; Daeli & Mohagheghi, 2023; Dugan et al., 2021). Extreme weather events put power grid systems under increased stress, and aging systems in the US are not well equipped to withstand these events (Andresen et al., 2023; Casey et al., 2020; Daeli & Mohagheghi, 2023). Extreme heat and cold events also result in high demands for electricity year round as people attempt to regulate indoor air temperatures (Andresen et al., 2023; Casey et al., 2020; Daeli & Mohagheghi, 2023). These higher electricity demands are also a significant stressor for power grid systems, which

increase the chance of brownouts (temporary periods of reduced voltage that can harm electronics) and blackouts (Andresen et al., 2023). Increasingly, utilities are turning to public safety power shutoffs (PSPS) as a proactive and preventative way to reduce catastrophic wildfire risk during high wind events (Huang et al., 2023).

According to the Oregon Department of Energy, 51% of homes in Marion County and 54% of homes in Polk County rely on electricity as their primary heating source for their home. Energy burdens are a related concern. Households are considered energy burdened if more than 6% of their income is spent on home energy costs. In Marion County, 28% of households are considered energy burdened, and in Polk County, 23% are considered energy burdened. Energy systems in Marion and Polk Counties are vulnerable to outages due to increased demand, winter storms, wind, and wildfire events. Droughts and decreased snowpack can also negatively impact power generation and supply. For example, a recent analysis by the U.S. Energy Information Administration noted that hydropower generation was 20% lower in Oregon and 23% lower in Washington during the 2022-23 season compared to the year before due to drought. Other forms of electricity also depend on water for cooling purposes.

Ensuring that power grids are designed to be resilient in the face of extreme weather is a critical step in reducing the social impacts of power outages (Andresen et al., 2023; Casey et al., 2020; Daeli & Mohagheghi, 2023; Dugan et al., 2021). There are many different strategies that can be utilized to improve power system resilience, including preventive measures to be implemented in advance, corrective measures which can be utilized while the event occurs, and restorative measures which take place after the event has ended (Daeli & Mohagheghi, 2023; Dugan et al., 2021). Preventive measures are focused on strengthening the power system and may include using stronger poles for overhead lines or installing underground cables (Daeli & Mohagheghi, 2023). Corrective measures seek to maintain functionality within the power grid system and minimize disruptions to electricity supply (Daeli & Mohagheghi, 2023). Restorative measures are often focused on finding alternative ways to supply power while the system is being repaired, such as using mobile energy storage systems as an emergency power source (Daeli & Mohagheghi, 2023; Dugan et al., 2021). When considering various preventive, corrective, and restorative measures to take, it is critical to understand that there is no single way to improve grid resilience that is widely applicable because this issue is extremely case dependent (Dugan et al., 2021).

Public Health Impacts

There are a number of health impacts that can result from power shut offs. A key concern in the literature is that of carbon monoxide poisoning resulting from improper generator use or

use of alternative fuel sources indoors, particularly around children (Andresen et al., 2023; Casey et al., 2020). Other health concerns include food poisoning from spoilage, injury, and temperature related-illness due to heat or cold exposures (Andresen et al., 2023; Casey et al., 2020; Rubin & Rogers, 2019). There is also an increase in hospital visits for patients experiencing renal, cardiovascular, or respiratory symptoms during outage events, which stems at least partly from the impacts on electronic medical devices reliant on power (Casey et al., 2020). Power outages can also impact access to safe drinking water for residents reliant on electricity to pump water to higher floors of residential buildings (Dominianni et al., 2018) and well users.

There are also mental health consequences that arise from power outage events, particularly in longer outages, owing to uncertainty around access to basic survival needs (i.e. food, medicine, water, etc) (Andresen et al., 2023; Casey et al., 2020). One study examined mental health following the 2021 winter storm related power outages in Texas by examining digital communications to the Crisis Text Line (CTL). Areas more impacted by the storm showed increases in crisis texts mentioning suicide and anxiety symptoms for the duration of the study - which looked at up to 11 months post storm (Sugg et al., 2023). While the study itself focused more on the quantitative patterns related to the CTL changes, the authors note, “The anomalous winter weather event and subsequent power outage in Texas had cascading effects on other services reliant upon electricity, including water, medical services, and indoor heating. While all socio-economic groups were affected, the storm was especially hard on low-income families residing in older, poorly insulated homes with outdated plumbing and limited resources to relocate, repair home damage, or replace spoiled food” (Sugg et al., 2023, 2). It is often the compounding sum of these impacts that lead to mental health stressors during and following power loss events.

Health Impacts on Vulnerable Groups

Broadly speaking, groups that are vulnerable during power outages includes older adults, patients reliant on electrical medical equipment, those with underlying health conditions, children, people of color, low-income people, rural residents, and non-English speakers (Andresen et al., 2023; Casey et al., 2020; Rubin & Rogers, 2019). Older adults and individuals who rely on electrical medical equipment may be more vulnerable during power outages because they may not have enough medication to withstand the outage, cannot refrigerate medication properly, or do not have electricity to power life-assisting medical equipment (Andresen et al., 2023; Casey et al., 2020). This may be exacerbated in lower-income households.

In California, vulnerable households reported high levels of distress, physical impairment, and psychological harm from public safety power shutoffs (Wong-Parodi, 2020). This recent survey of California residents asked about vulnerabilities in the household (respiratory disease, heart disease, diabetes, allergies; life course such as younger than 5 years or older than 65 years; or low income), past experience with PSPS, and health concerns related to PSPS. Those with higher vulnerabilities were more likely to have experienced a PSPS, and were generally more concerned about the consequences of PSPS. At the same time, these vulnerable groups were more supportive of the shutoffs because they determined that the risks they faced from power outages were less severe than the ones they would experience from increased wildfires. Concerns about health and social determinants of health were prevalent across all respondents. worried about food loss, 71 percent worried about medical needs, and 67 percent were uncertain if they would be able to complete daily activities. Nearly 45 percent were concerned about work or school, 22 percent were worried about childcare, and 22 percent were worried about staying cool (Wong-Parodi, 2020).

To characterize durable medical equipment usage, a study by Casey et al. (2021) examined records of 243,599 medical equipment renters. The study focused on renters to better capture usage among lower-income groups. They found that about 40% of these members were renting breast pumps. Of the non-breast pump users, most were over the age of 65 and about 25% relied on multiple types of equipment (Casey et al., 2021). A New York-based study found that families who had someone reliant on electric medical devices were more prepared for outages than those who did not. However, while 70% of the families met the criteria for being prepared, they had lower perceptions of being prepared and only 40% were registered with the power company. Families with young children were also found to be less prepared. Respondents who were Black, Latino, and/or had incomes under 100,000 were more concerned about the health impacts during outages (Dominianni et al., 2018).

Improvements in individual and community preparedness can help prevent many of these negative health outcomes and address the needs of vulnerable groups during power outages (Andresen et al., 2023; Casey et al., 2020; Rubin & Rogers, 2019). It is important to also recognize the capacities for resilience and coping within these groups. For example, while older adults in Chile were more vulnerable in some ways after the 2010 earthquake, they also had extensive local knowledge that helped the community navigate afterwards (Moreno & Shaw, 2019). Similarly, a study based in the UK highlighted that participants in their study who were disabled were as able to cope with power outage events as those in the study who were non-disabled. However, Participants spoke of cumulative lived

experiences that have required them to be more prepared for events and have facilitated their abilities to navigate outages. This was especially true for people who had lived in the region for longer periods of time (in this study, 15 years or more) who had experienced local outages before and were familiar with resources available to them (Connon & Hall, 2021).

Recommendations, Needs, and Key Resources

Power outage preparedness is essential because it will help reduce negative social, health, and economic outcomes (Andresen et al., 2023; Casey et al., 2020; Rubin & Rogers, 2019). People may not be prepared when power outages occur due to specific vulnerabilities or systemic barriers to preparedness, but another factor may be individual risk perception (Rubin & Rogers, 2019). Individuals may not take steps to prepare for a power outage if they perceive the risk of an outage and its impacts to be low. However, once individuals have experienced a power outage they are more likely to have better knowledge about safety measures and be more prepared in the case of future outages (Rubin & Rogers, 2019). When people take steps to prepare for an outage it reduces poor health outcomes, however vulnerable groups may need more support to ensure preparedness and prevent health issues (Casey et al., 2020).

Steps to ensure vulnerable groups are not disproportionately impacted during a power outage may include (Andresen et al., 2023):

- improved communication about safety and preparedness;
- creating plans for medically vulnerable individuals prior to outages; and
- directing resources to communities that may experience prolonged power outages such as rural areas, low-income communities, and communities of color (Andresen et al., 2023).

The ADA's National Network has an Emergency Power Planning checklist for those who use electricity and battery-powered medical devices. It is recommended that users go through the list twice per year. The checklist is also available in large print format. Key sections on the checklist include:

- Planning basics
- Life-Support Device Users
- Oxygen Users
- Generator Users
- Rechargeable Batteries
- When Power is Restored
- Other Backup Plans

Community emergency plans should work to address the socioeconomic inequities associated with power outages in order to improve outcomes during these events (Casey et al., 2020).

Extreme Heat

Managing heat has increasingly become a major challenge in Oregon and within the Willamette Valley specifically. While hotter days and warmer, longer summers are becoming the norm, Marion and Polk Counties and surrounding areas were deeply affected by the Pacific Northwest Heat Dome of June 2021. As a result, there has been increased attention at the state and local levels, most notably resulting in SB 1536, to documenting heat health needs and implementing programs to protect vulnerable populations.

Heat is typically defined as daytime temperatures and can be examined using different definitions:

- **Frequency**: The number of hot days, defined as maximum ambient temperature at or above 90°F, has doubled over the past 125 years. The measure has gone from under 10 days on average in the first quarter of the twentieth century to over 20 days for the past 25 years in Salem. Some years are much worse, with 41 days above 90°F in 2021. (See Figure 23 below)
- **Duration**: There are also longer streaks of extremely hot days. For example, at least one streak of consecutive days over 90°F lasting longer than a week is now more common than not.
- **Intensity:** All time maximum high records are also increasing. The Pacific Northwest Heat Dome of 2021 resulted in recording 113°F on June 27th followed by 117°F on June 28th, smashing a previous 40-year old record of 108°F. Similarly, 2024 saw the longest over 100°F streak on record (5 days).

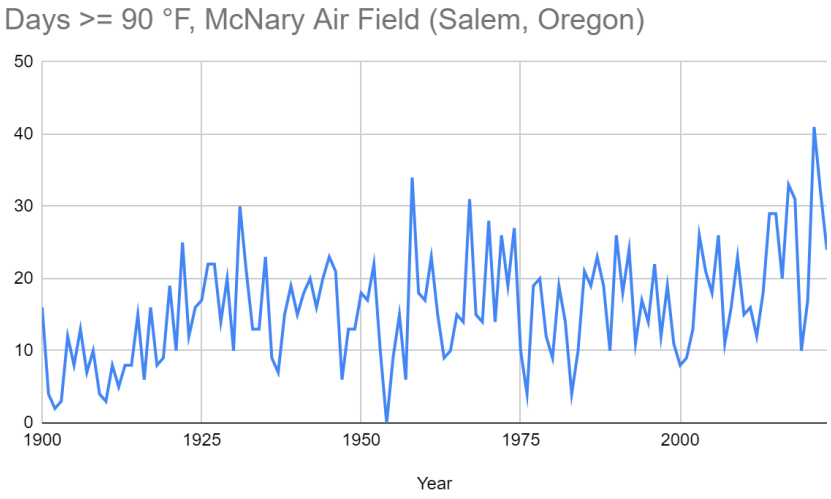


Figure 23. Number of days above 90 degrees F. Source: https://www.extremeweatherwatch.com/cities/salem-or/yearly-days-of-90-degrees

Public Health Impacts

Exposure to heat is associated with mortality and morbidity. In a recent major meta-analysis of heat illness such as heat stroke and dehydration, a 1°C (1.8°F) increase in temperature was associated with an 18% increase in heat related illness and 35% increase in heat related death (Faurie et al., 2022). In another meta-analysis that pooled data from 266 studies with a cardiovascular endpoint, a 1°C increase in temperature was associated with a 2.1% increase in cardiovascular mortality and a 2.1% increase of out-of-hospital cardiac arrest (J. Liu et al., 2022). The impact is even greater in extreme intensity heatwaves such as the 2021 PNW Heat Dome where cardiovascular mortality levels increase, on average, by 18.9%.

Table 15. Recent meta-analysis documenting relationship between heat, morbidity, and mortality.

Author (Year)	Heat Definition	Health Endpoint	Relative Risk
Faurie et al (2022) 30 studies	Temperature increases (every 1°C)	Mortality from heat illness	RR = 1.35 [1.29-1.41]
		Heat illness morbidity	RR = 1.18 [1.15-1.19]
Liu et al (2022)		Cardiovascular Mortality	RR = 1.021 [1.020, 1.023]

266 Studies	Temperature increases (every 1°C)	Out-of-hospital cardiac arrest	RR = 1.021 [1.010-1.032]
	Heatwave - Moderate intensity	Cardiovascular Mortality	RR = 1.088 [1.058-1.119]
	Heatwave - High intensity	Cardiovascular Mortality	RR = 1.189 [1.109-1.269]

Exposure to heat can cause a variety of negative health effects short of death. ER visits and hospitalizations increase during heatwaves (Ebi, 2019) and ambulance use have been documented to increase when outdoor temperatures increase (Xu et al., 2023). The most common severe health effects include heatstroke, heat exhaustion, and dehydration (Cardoza et al., 2020; Faurie et al., 2022; Guirguis et al., 2018; Hopp et al., 2018) as well as cardiovascular and respiratory issues (Cardoza et al., 2020; Guirguis et al., 2018; Hopp et al., 2018; J. Liu et al., 2022). Acute renal failure (Guirguis et al., 2018; Hopp et al., 2018) and preterm births (Ebi, 2019) rise with high temperatures as well. Higher indoor temperatures have also been found to worsen sleep (Williams et al., 2019). Heat has also been linked to decreased mental health (Ebi, 2019; Guirguis et al., 2018; Palinkas et al., 2022) including stress, negative emotions, the emerging or worsening mood and behavior disorders, and increases in suicide and homicide (Palinkas et al., 2022).

Health Impacts on Vulnerable Groups

Age is the primary influencing risk factor due to physiological differences over the life course. Older adults (Arnold et al., 2022; Cardoza et al., 2020; Dring et al., 2022; Hopp et al., 2018; Khatana et al., 2022) and young children (Cardoza et al., 2020; Dring et al., 2022; Uibel et al., 2022) are both at higher heat risk due to a weaker ability to regulate internal temperature and greater susceptibility to heat-related illnesses. Additionally, children and young adults tend to participate in higher levels of physical exertion in the high temperatures (Dring et al., 2022), resulting in a quicker rise in body temperature. People with preexisting conditions such as cardiovascular disease, respiratory disease, and diabetes are also at higher risk (Arnold et al., 2022; Cardoza et al., 2020; Kearl & Vogel, 2023). Children are at risk of general heat illness, electrolyte imbalance and dehydration, diarrhea and digestion disorders, infection, asthma complications , and injury; children are generally not at risk of renal disease, cardiovascular disease, or diabetes (Uibel et al.,

2022). Student athletes are also at high risk of exertional heat stroke when temperatures are elevated (Adams, 2019).

Other groups that may be at higher risk of heat exposure include lower income individuals who have less control over housing quality including installation of air conditioning, less resources to pay for air conditioning, and documented disparities in tree canopy and islands of cooling greenspace (Kearl & Vogel, 2023).

Occupational Risk: Those who work in non-air conditioned or outdoor spaces are at much higher risk of extreme heat exposure; additional biological risk accrues if the work involves physical exertion (Fatima et al., 2021; Gibb et al., 2024). Practically speaking, outdoor workers such as construction workers, landscapers, agricultural workers, and first responders are at elevated risk for prolonged heat exposure (Fatima et al., 2021; Gibb et al., 2024); much of the recent literature has focused on these populations, especially since many workers also have other underlying social vulnerabilities that amplify risk (Castillo et al., 2021). Additionally, the already hot conditions and unairconditioned spaces for indoor factory workers, workers at distribution centers, and kitchen workers can tip into dangerous levels during moderate heat events (Gibb et al., 2024). Incarcerated workers are likely at even higher risk when participating in any of these occupations (Gibb et al., 2024).

Extreme intensity heatwaves, particularly early in the season before workers acclimatize to summer temperatures, are particularly risky. Unlike non-occupation risk, epidemiological studies suggest younger, male workers tend to be more likely to be impacted by heat (Fatima et al., 2021), perhaps because they underestimate the true risk of prolonged, extreme heat for relatively healthy individuals.

Recommendations, Needs, and Key Resources

Short, intense periods of heat at or above 100°F in our region require active, adaptive management (Hess et al., 2023) similar to an extreme storm. Actions that could help build resilience to this situation include:

- Engage with regional partners in Oregon, Washington and British Columbia about early warning systems Early warning systems for extreme heat events.
- Prepare with stock messaging in multiple languages for multiple modes of communication.
- Maintain capacity to access the syndromic surveillance system (ESSENCE) in real time and participate in Oregon-level indicators.
- Continue to expand access to formal and informal cooling centers.

- Collaborate with emergency management and utility providers to simulate cases of an overstressed electrical grid due to extreme heat and the best response(Stone et al., 2021).

Longer streaks of 90-100°F days puts extreme pressure on older adults, young children, those working or living outdoors, those unable to afford additional energy expenses from air conditioning, and anyone living in an older building without air conditioning. Additionally, more heat-related deaths are indoors rather than outdoors (Samuelson et al., 2020) including during the 2021 PNW Heat Dome event (White et al., 2023), highlighting that access to indoor, air-conditioned space is just as important as avoiding spending time outdoors.

- The Oregon Cooling Needs Study commissioned by the Oregon Department of Energy has excellent information about needs by housing type.
- Continue to assist community organizations and community members access state level resources from SB 1536 to improve AC coverage for those at highest risk.
    - Educate the community about the OHP air conditioner program.
    - Consider amplifying the air conditioning program with a clean energy program (see Cooling Portland as an example).
    - Include tenant "right to cooling" in educational materials.
- Collaborate with community organizations to provide informal cooling centers for those most at risk when temperatures do not trigger opening of official centers.
- Amplify Oregon's occupational Heat Illness Prevention Rules in educational and emergency management campaigns.

Even longer, hotter summers with temperatures routinely about 85°F may result in behavioral changes, such as reduced outdoor physical activity mid-day or require careful management of school closures late and early in the summer.

- Collaborate with county and municipal parks and recreation staff to assure recreational opportunities and programming accounts for increasing summer heat. Examples might include:
    - Increasing shade and water features and leveraging cool mornings and early evenings. https://cnr.ncsu.edu/news/2023/08/extreme-heat-outdoor-recreation/
    - Monitoring, and in extreme cases, temporarily suspending athletic permits during heat events.
- Collaborate closely with Salem-Keizer and other school districts to plan for late-spring and early-fall heatwaves. The Arizona Department of Human Services has a good example of how to create a district level heat plan to manage extreme heat in schools.

Longer streaks of high temperature increase nighttime ambient temperatures, resulting in less time for the body to recover and reset for the hotter days. This likely explains why the

National Weather Service found that only 12.7% of heat-related deaths occurred during heatwaves while the rest occurred during non-heatwave days (Abasilim & Friedman, 2022).

- Add nighttime lows as an additional indicator for decision-making.

There is also evidence that injuries such as downing, reckless driving, and violence increase as the temperature increases (Hess et al., 2023).

- Increase mental health resources during the summer months.

Vectors

Context and Scope of Vectors

Vector-borne diseases, such as those spread by ticks and mosquitoes, have particularly complex ecological dynamics that are influenced by a number of other environmental factors discussed in this report, such as heat, drought, and flooding. These environmental variables may differentially impact humans, vectors, viruses, habitats, and animal hosts and reservoirs, making projections challenging. Nevertheless, the OHA expects Lyme and WNV to increase in Oregon in the future.

While less abundant than other parts of the country, **ticks** and tick-borne pathogens are reported in Marion and Polk Counties. A key vector of concern is *Ixodes Pacificus,* which is found predominantly in California, Oregon, and Washington, and spreads the pathogens that cause Lyme Disease, Anaplasmosis, and hard tick relapsing fever. A review of records and reports documenting *I. pacificus* in Oregon from 1893-present notes three regions that span Marion and Polk Counties (Cascades, Willamette Valley, and Coast Range) as being more suitable due to cooler temperatures and high levels of precipitation (Eisen et al. 2024). Changing weather conditions could further support an increased range expansion of *I. pacificus* at higher elevations in the Cascade range (Eisen et al. 2024). Current tick surveillance data from 2023 by the CDC classifies *I. pacificus* as "established" in Marion County and as "Reported" with "suitable habitat" in Polk County. A total of 10 human Lyme Diseases cases and 29 canine cases were associated with a Marion County residence between 2019-2022, and 3 human Lyme Diseases cases and 7 canine cases were associated with a Polk County residence for the same period (Geographic Distribution of Tickborne Disease Cases | Ticks | CDC; CAPC Lyme disease Maps)

At present, **mosquitoes** in Marion and Polk Counties are predominantly only a nuisance to humans. The majority of reported West Nile Virus cases in the state occur east of the Cascades. Still, annual climate variability can make some years more prone to

mosquitoes and ultimately increase concern of disease outbreaks, such as in Multnomah County in 2021. Given the lack of current mosquito control and surveillance in Marion and Polk Counties, it is helpful to look at nearby counties with similar environmental characteristics for an overview of likely vectors. Table 16 denotes the presence of mosquito pools collected and tested for WNV during 2020, 2021, and 2020 for Clackamas, Columbia, Lane, Linn, Multnomah and Washington counties. Not included in the table below is Ochlerotatus japonicus, an aggressive biter that is known to transmit WNV, has also been detected in Multnomah County.

Table 16. Collected mosquito pools tested for WNV in nearby counties. Data sourced from the 2022, 2021 & 2020 State of Oregon West Nile Virus Summary Reports. Notes on medical importance and/or habitat notes in Oregon supplemented from Oregon Mosquito and Vector

	Aedes vexans WNV, WEE, Pest Habitat: floodwater; irrigated areas	***Anopheles punctipennis*** Malaria (past) Cascades, clear pools	***Anopheles freeborni*** WEE Clear pools; marshes; irrigated pastures	***Coquillettidia perturbans*** WNV Marshes; ponds w/ vegetation	***Culex Pipiens*** WNV - Stagnant water; artificial containers; cesspools	***Culex tarsalis*** WNV, WEE, SLE irrigation ditches; Containers; Wetlands	***Culiseta incidens*** Pest Natural depressions; artificial containers
Clackamas	x	x			x	x	x
Columbia	x	x		x	x	x	
Lane	x				x	x	
Linn	x	x			x	x	
Multnomah	x	x	x		x	x	x
Washington		x		x	x	x	

Notable vectors in our region are Aedes vexans, Culex pipiens, and Culex tarsalis. Ae. vexans is also known as the “Inland Floodwater mosquito.” The mosquito lays eggs in moist soil that becomes inundated with floodwater (O’Malley, 1990). Cx. pipiens, or the “Northern House Mosquito” can breed in water with high organic content, such as in septic tanks, as well as in artificials containers, storm drains and catch basins. In contrast to Cx.

pipiens which tends to favor more populated areas, Cx. tarsalis is more abundant in rural and agricultural areas (Bowden et al., 2011).

Recent analyses suggest that Oregon may become more suitable for mosquitoes that currently do not reside here, such as *Aedes aegypti* and *Ae. albopictus* (S. U. Khan et al., 2020). These mosquitoes are responsible for vectoring a number of diseases of medical importance, including a number that have recently been transmitted in the US, such as WNV, dengue, zika, and chikungunya (though, it is important to note that environmental suitability for the mosquito does not necessarily mean suitability for a given virus). Both mosquitoes have been found as far north as Redding, California, in Shasta County, commonly breed in artificial containers (such as plant saucers, items sitting in the yard, bottle caps, etc), are aggressive biters, and quite adept at establishing themselves around human dwellings. This can make management particularly difficult given that these spaces are often on private property.

Health Impacts on Vulnerable Groups

Ticks are known to be a particular concern to **outdoor workers**. USFS employees in the upper midwest reported high tick exposures and significant concern about contracting illness as a result (Schotthoefer et al., 2020). While the Upper Midwest is known to have substantially more tick activity, former USFS workers in Oregon have also spoken about tick exposures on the job [personal communication, 2018]. Interviews with Federal region X workers, which includes Oregon, noted vector-borne diseases as one regional occupational health concern. Groups identified in this study more at risk to these occupational environmental health concerns included **guest workers,** and outdoor workers in industries such as **agriculture, logging,** and **public works** (Pedersen et al., 2021). Marion county has the second highest number of migrant seasonal farm workers in the State of Oregon. Individuals who spend time outside **hiking or gardening** are also at risk of tick exposures.

In terms of **mosquitoes,** it is well established that **adults over the age of 60 and individuals with preexisting conditions** are at highest risk of serious illness from West Nile virus. **Socio-economic conditions**, such as a lack of window screens or air conditioning also increase susceptibility to mosquito bites, particularly for container breeding species, like *Ae. aegypti* and *Ae. albopictus*. **Unhoused populations** are also at a higher risk of mosquito exposures.

Recommendations, Needs, and Key Resources

The limited tick surveillance done at national and local scales is frequently noted as a challenge to fully understanding pathogen prevalence and exposure risk (see (Eisen & Paddock, 2021)):

- The CDC's Surveillance for Ixodes pacificus and pathogens found in this tick species in the United States documents tick surveillance objectives and practices for *I. pacificus* in the western US.
- One method that has been documented to supplement surveillance efforts is a citizen science participation program (Nieto et al. 2018). Habitat suitability models based on the information sent in by citizen scientists were also created, and authors note this was particularly useful for increasing understanding of *I. pacificus* in Oregon and Washington states, which have much less active surveillance data than California (Porter et al. 2021).
    - This study details the method used for the tick citizen science program. Using citizen science to describe the prevalence and distribution of tick bite and exposure to tick-borne diseases in the United States | PLOS ONE
    - This is an example of what was shared with citizens to encourage their participation in the program Tick Testing - Bay Area Lyme Foundation

Integrated Mosquito Management (IMM) is a dominant approach to mosquito control used by vector control districts and other local entities responsible for reducing mosquito burdens. As outlined in the CDC's overview of IMM, the key components include, "surveillance, source reduction, control of all mosquito life stages, insecticide resistance testing, public education, community involvement, and evaluation of actions taken". These components reflect the diversity of approaches needed to manage a range of mosquito species with varying habitat preferences.

- The American Mosquito Control Association has a 13 module program available at no cost: AMCA's Best Practices for Integrated Mosquito Management Virtual Training Program

Importantly, mosquito control needs to occur in both public and private spaces. Because many disease vectors breed in and around homes, facilitating public awareness, education, and other needs to control mosquitoes on their properties is a crucial role for public health departments.

- Awareness campaigns, such as CDC's Fight the Bite have been central to encouraging citizens to take personal protective behaviors (PPBs) and reduce

mosquito breeding sites around their properties. The CDC maintains a bank of Communication Resources for both this and other campaigns for tick and mosquito control. It also has published Bite Prevention: Results from Focus Groups with At-Risk Audiences infographic which gives a high level overview of responses to different PPBs and communication preferences voiced in focus groups.

- The Greater Los Angeles Vector Control District has a checklist in English and Spanish that clearly outlines the spaces around the home that should be inspected as a potential breeding site.
- The use of Gambusia (Mosquitofish) can also supplement the use of PPBs and removal of standing water on private properties in some instances. It is important to note that these fish are not native to our area, and there are ecological concerns should they be released into our local waterways that should be considered in advance of encouraging their use. When adopted, they should only be used in "artificial or human-made self-contained waterbodies, such as aquariums, livestock troughs and ornamental ponds that are not fed or drained by natural waterways. Natural water bodies, such as ponds, streams, rivers of lakes or other waterbodies that may be flooded are off limits for mosquitofish (See Oregon Revised Statutes 498.222)" (ODFW Backgrounder, 2009). Several nearby counties do have programs that support mosquitofish use, such as Multnomah and Clackamas Counties.

Overarching Findings and Recommendations

Role of Local Public Health

Preparing for and managing through EHHTs would benefit from an explicit social determinants of health approach.

- There is ample evidence that all of the EHHTs discussed are impacting physical and mental health directly.
- Many EHHTs also greatly impact upstream, social determinants of health such as ability to travel and maintain employment, accessing basic needs (electricity, food, water, medication, and healthcare) and ability to interact with social circles.

Health equity should be a constant frame through which to allocate resources and target communication.

- There is a growing body of evidence that suggests vulnerable populations are at higher risk of exposure, have more biological risk factors, and have less access to resources – economic and social – to buffer exposure to EHHTs. EHHTs should be considered in the context of cumulative health risks and health equity.
- Vulnerability varies by EHHT, and planning and implementation will need to account for this variation.
- There is also a growing body of literature that suggests EHHT communication from both government and media sources does not clearly articulate vulnerabilities or target the most vulnerable.

The public health departments of Marion and Polk Counties are well positioned to facilitate opportunities for community partners to improve their understanding of EHHTs and create improved communication networks for resilience.

- Community partners understand and are concerned that EHHTs are impacting their operations and the populations they serve on a regular basis. They are asking for a more proactive approach to preparing for EHHTs.
- Many community partners are service providers who already engage with the counties' public health, behavioral health, or other human services branches. These community partners do need more education and guidance about the EHHTs themselves to tailor their approaches to the populations they serve.

- Conversely, many environmental and government agencies recognize the need to focus on vulnerable populations, but need help understanding the nuances of these approaches.
- Public health is well positioned to convene and facilitate among all of these angles and interests.

Communication Planning

A communication plan should be developed for each EHHT and updated on a predictable cycle.

- EHHTs are often fast-moving, emergent events. Preparing a communication plan with template materials prior will allow for timely information push out, maximize resources, and smooth internal efforts.
- Each of the major EHHTs are different enough in scope, interventions, vulnerable populations, and communication networks to warrant their own communication plan.
- Circumstances, best practices, resources, and underlying public knowledge change over time. Communication plans must be updated to account for these changes.

EHHT communication must continue to be a multi-pronged, multi-media approach.

- Most people self-report that the internet is their preferred first way to look for information.
- Many are reliant on social media for information.
    - While Facebook continues to be the dominant platform, particularly amongst middle-aged residents, a multi-platform approach is required to reach a wider audience.
    - The county should list and link to all platform accounts on appropriate webpages and include a list of accounts with links in banner notifications during emergent events.
- Some vulnerable populations do not prefer social media or the internet. They may rely on traditional media (older adults), texting such as WhatsApp (non-English immigrants), phone trees (IDD caregivers), and direct contact or word of mouth (unhoused). These communication channels must continue to be supported.

EHHT materials should be made available in all languages.

- Every effort must be made to create materials in all languages. Some of the regions' most vulnerable populations do not have a solid grasp of English.
    - Given current language distribution in the region, all materials should simultaneously go out in English, Spanish, and Russian.

    - Refugee and migrant workers are at particularly high risk, with many speaking yet another, often indigenous, language. This is expected to increase over time.
- Organizations that primarily serve limited-English populations are willing to augment, but are frustrated by the time lag in emergent situations.
- Simple, clear messaging is easier to translate and accessible to a wider range of reading ability.
- Short, written messages that can be quickly translated and sent via a texting app (WhatsApp) serve many of these populations best.

EHHT materials should be improved with respect to accessibility.

- The effort to make messaging visually appealing sometimes results in loss of accessibility. All infographics should be accompanied with alternative text.
- Consider educational materials that are more tactile or experiential to reach IDD, children, and older adult populations.

Communication plans should articulate well-timed preparation messaging on an annual basis.

- While it is possible to oversaturate and lose the public's attention, repeated messaging meets the needs of the most vulnerable.
- Most EHHTs have a seasonality component; well-timed preparation material on an annual basis could help create a culture of emergency preparedness and slowly ramp up the knowledge base.

EHHT-specific findings & recommendations

Extreme Heat

The region should expect annual moderate-risk heat (90 degree days) and high risk heat (100+ degree days) days and plan for a repeat heat dome scenario of 110+ degrees. The public health evidence for extreme heat increasing mortality and morbidity is well developed.

- Some populations are at higher heat health risk than others.
    - Older adults and the unhoused are at the highest risk from extreme heat.
    - Those who do not have access to air conditioning whether due to occupation, income, or poor quality housing are also at high risk of adverse health impacts.
    - Physical exertion – for occupational or recreational – in heat is a major behavioral risk factor.
- Access to air conditioned spaces is the primary intervention to reduce risk of extreme heat exposure.

- Residential adoption of air conditioning is happening at an accelerated pace, but up to 20 percent of the county likely does not have access to a residential air conditioned room.
- Communication in mid-spring should incorporate messaging about
  - a renter's legal right to place air conditioners in windows; and
  - any programs that subsidize air conditioner purchases.
- In anticipation of a heatwave, communication should focus on having a household plan for cooling via residential air conditioning or cooling centers.
- Adoption of air conditioned spaces lags in both occupational and education (K-12) settings; county leadership to engage institutional leaders may help close this gap.

➢ Oregon's recent legal frameworks for heat for housing code and occupational standards is a solid foundation which the county could augment.
- Community partners suggest implementation of occupational and housing standards is uneven. While these are largely state statutes, the county may have a role to play in educating people of their rights.
- Continue to support state and local legislation that resources air-conditioning retrofits, perhaps leveraging clean energy programs.

Wildfire Smoke

Wildfire season is now an established phenomenon in Oregon and the probability of at least a few days annually of wildfire smoke in the mid-Willamette Valley from mid-summer until the fall rains is high. The negative respiratory and cardiovascular health impacts of $PM_{2.5}$ exposure – the primary pollutant of interest in smoke events – are well established. This includes exacerbation of respiratory and cardiovascular conditions from even a single day event.

➢ The public in Marion and Polk Counties is well-primed to address wildfire smoke.
- Wildfire smoke is a regional challenge, which means most people have direct experience with smoke, are concerned about it, and believe wildfire smoke will continue to be a problem.
- Of all EHHTs, residents are most likely to understand the linkage between smoke and health.

➢ While primary prevention of wildfire smoke is closely linked to wildfire prevention, indoor filtration and personal protective equipment when outdoors can reduce exposure.
- Filtration with MERV13 or HEPA filters is the first line of defense indoors.
  - Every household should have a plan for a "clean room" that seals off outdoor air and provides MERV13 or HEPA filtration within the room when smoke levels rise. A similar approach could be taken in workplace settings.
  - Managing filtration must take air-conditioning into account: air conditioners that allow for recirculation of air that can be run with a

MERV13 filter can help clean the air. Otherwise, a relatively affordable standalone filter (such as a Corsi-box fan setup or a standalone unit) can serve as the filter.
    - In workplaces (indoors and outdoors) where filtration is not possible, employers should be encouraged to provide N-95 masks to reduce exposure to particulates.
    - The current OHA Air Filter program is restricted to counties south of Marion. The counties should work with OHA to expand the geographical coverage and/or augment this program for those with medical needs and currently receiving benefits from Oregon Health Plan or Medicare.
- Communication strategies for smoke should be regional in nature and incorporate the following:
    - Messaging about wildfire smoke must incorporate the co-exposure of heat in the mid-Willamette Valley region.
        - The vast majority of wildfire smoke days in the mid-Willamette Valley happen because the offshore winds are weak enough for smoky, hot, eastern air to enter and stay in the valley.
        - There is growing evidence that co-exposure to smoke and heat is particularly damaging to health and disproportionately impacts vulnerable populations.
    - Prior to smoke season, annual messaging should focus on having a smoke plan including having an extra filter on hand, how to plan for a clean room, and sourcing N-95 masks for those who must be outdoors (unhoused, outdoor workers).
    - During smoke events, messaging should focus on reasonable environmental interventions and behavioral changes, lean heavily on the AQI system, and contain specific mentions of those who are most vulnerable.
    - Because wildfire smoke is a close cousin to poor air quality days caused by inversion layers trapping particulates in the winter, communications of these two hazards can be closely coordinated.
- Children – and particularly those with asthma – are disproportionately susceptible to wildfire smoke and may be disproportionately exposed during the early part of the school year.
    - Prioritizing children's education is vital to health and wellbeing. Weighing educational needs against the risk of smoke and heat can be difficult. Schools and athletic programs could benefit from public health's input in creating plans to guide reducing outdoor time and/or canceling afterschool events or school.

Winter Storms, Ice and Power Loss

Marion and Polk Counties are in a unique geographic position which results in wintery mix storms during the winter. This makes ice storms highly likely.

- Ice storms are likely to result in power loss, which can create cascading health impacts as food and medicine spoil and heating becomes impossible.
    - Communicate preparation messages such as:
        - charge all batteries;
        - have a plan for keeping warm and accessing food; and
        - reduce travel.
    - Explore ways to help those with life-saving medicine needs stockpile in anticipation of a storm.
- There is increasing evidence that the stress of major ice storms can cause stress and negatively impact mental health. Consider increasing mental health messaging post storm.

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