



**Knowledge Exchange for Resilience &
Arizona Association of Manufactured
Home Owners (AAMHO)**

Community Partner Report

2022

A network diagram with yellow nodes and lines on a dark background, located in the top right corner of the page.

Share.

Discover.

Solve.

**Table of
Contents**

- **Introduction**
- **Timeline of Partnership**
- **2022 Milestones**
- **2022 Projects**
- **Recommendations and next steps**
- **Our Mission**
- **Research Publications**
- **Media Coverage**
- **Our Joint Community and University Research Team**
- **Appendix**



Introduction

We value our collaboration with AAMHO as a community partner and aim to continue performing responsive research that drives profound and enduring change. Together, we liberate, analyze, visualize, and communicate knowledge to provide insights for action, laying the foundation for informed solutions.

This report describes our work and results of KER and AAMHO collaboration over 2022 following up with recommendations and plan for the 2023. It also includes new data, research publications and media coverage that supported this work.





Timeline of the partnership

2017

ASU and Piper Trust started working together to identify a way to address community heat resilience.

**December
2018**

Utility assistance network analysis and discovery. The "aha" moment happened when we discovered that mobile home residents fell between the cracks of utility assistance programs.

**Summer
2019**

Schmidt Futures project. Measuring, surveying and calculating the scope of the heat and health problem.

**January
2020**

Interpretation meeting with mobile home owners and study participants. Checking back and sharing the results with participants.

May 2020

Heat Resilience Solutions Meeting with stakeholders. Socializing the results more broadly among actors who might be able to mitigate and respond.



Timeline of the partnership

Summer 2020

Innovation challenge with Walton Solutions students summer interns.

Digging deeper into recommendations by participants and stakeholders to assess discrete solutions.

**August 2020
– April 2021**

EPICs student teams.

Working at the park scale to assess solutions and design sets of ideas in actual park conditions.

**June –
August 2021**

Mobile Home Solutions Guide.

Compiling everything we have learned in a way that can be used by multi-sector actors.

**August 2021
- Now**

Pilot phase effort.

Mobilizing a community of actors to create prototype solutions based on this exchanged knowledge/

2022

Milestones

March 25

Reviewed the Heat Mitigation Solutions Guide for Mobile Homes and identified the program of work for the year.

April 29

Began work on the Arizona Mobile Home Landlord & Tenant Act. Diana Bowman and Bryan Hull handed out several documents, including a state-by-state comparison of mobile home legislation.

May 23

KER provided updates on legal analysis, the list of owner-scale built solutions for heat and where to buy them, mapping updates, and SkyCool roofing project updates

June 27

Diana Bowman and James Ruberto presented information on landlord/tenant law followed by discussions on the SkyCool roofs.

August 8

KER presented updates on legislative analysis, eviction trends, utility affordability analysis, mapping inventory, heat solutions, AAMHO calls summary, complaint fact sheet, mapping complaints locations, and the analysis of the Census Household Pulse Survey *[see the full report in the Appendix]*.

September 19

KER shared the story and available data to be presented at the Conference on Aging. Members of AAMHO provided valuable feedback and suggestions to improve the presentation *[see presentation slides in the Appendix]*.

October 17

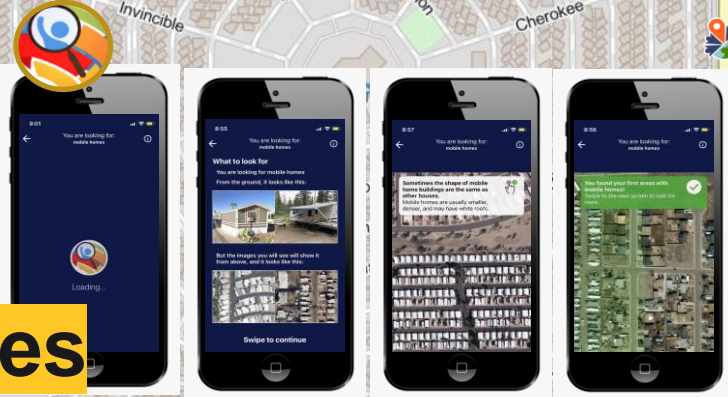
KER hosted the Conference on Aging and presented the research narratives of four years of knowledge exchange around heat resilience, particularly discovering together some of the hidden vulnerabilities among our older adult population who reside in mobile and manufactured housing. *[see the full report, program, and slides in the Appendix]*

2022

Milestones

2022 Projects

MapSwipe to build the map Mobile Homes



We discovered that there are no comprehensive and accurate databases of all mobile home locations. In order to locate all mobile homes and parks, our computer science and urban planning team activated a phone application called MapSwipe, which enlists hundreds of volunteers from anywhere in the world to review satellite imagery and find mobile homes visually. This tool is supported by the American Red Cross. For finding the locations, KER provided 49 missions representing a 4800 km² area within Arizona state. Amongst 49 missions we prioritized 13 missions including the highest populated areas to go live on the app first.

3,000+

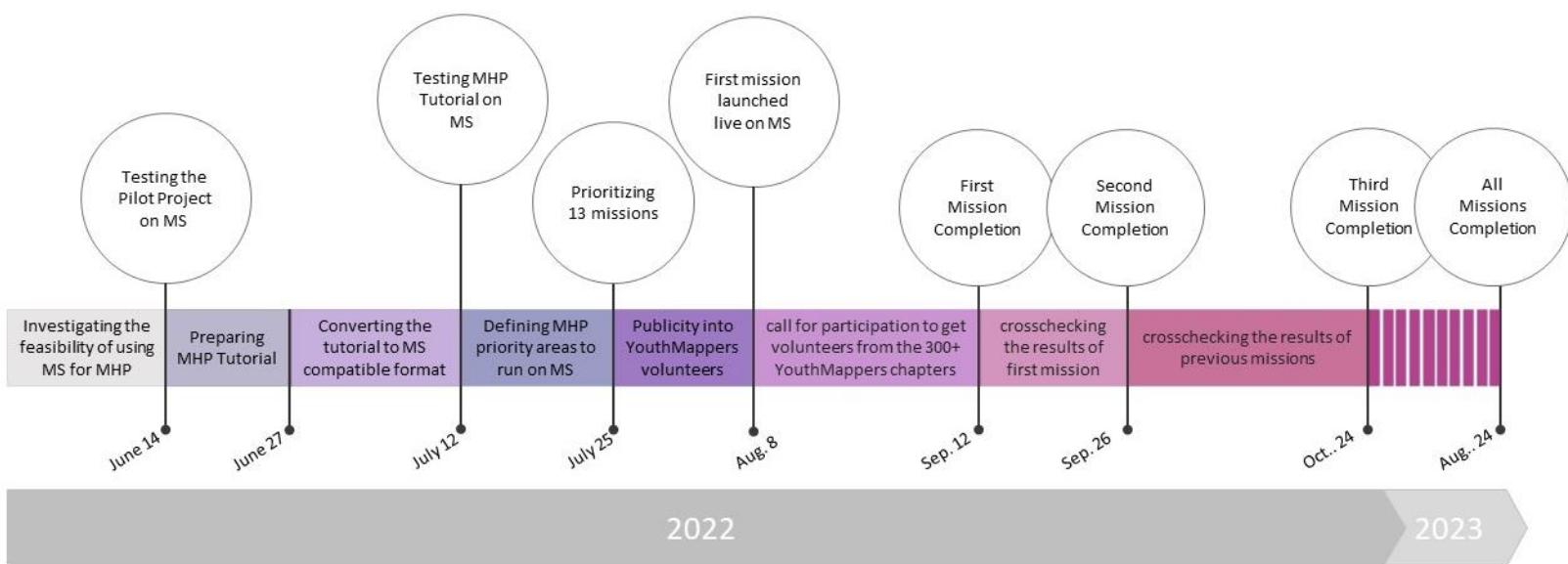
Mobile homes have been mapped

4 of 13

Priority tasks is completed

1194

Contributors



Mobile Home Project Timeline on MapSwipe

2022 Projects

Collaboration with 3M and SkyCool

In our effort to find and implement viable solutions to improve the heat resilience of mobile home residents, we engaged the private sector. One particularly exciting solution has come from a partnership with 3M and SkyCool. They have designed an experimental roofing product that helps keep homes cooler by rejecting heat. It's still in the experimental phase, but we were excited to complete the first pilot test mobile home installation of the product this summer and are attentively analyzing the internal and external temperatures to see how it performs. Working closely with our community members made this possible. An executive summary of the results of this project can be found in the appendix.



2022 Projects

Survey results



In June 2022, our team focused on developing and administering survey questions relating to heat impacts, heat mitigations, and other restrictions that may hinder heat adaptations. The survey was conducted in two stages - pre and post. In the first stage, we had ten participants, however, in the second stage, we had six participants as some of them moved during the summer. We administered follow-up survey questions about heat impacts, mitigation, and other restrictions.

This report simply summarizes the findings and does not portend to present any analysis due to low response numbers. It does, however, serve as a test and inform our aims for a state-wide survey across all of Arizona that KER plans to conduct with support from AAMHO in 2023. Complete survey results can be found in the appendix.

Summary of the main findings from the survey

House structure and ownership:

Most of the participants, 90%, live in a single-wide mobile home trailer. However, the exterior facade of the units appeared doublewide, considering the built-on awning on either side of the mobile home unit. These awning structures varied in size and style most of the spaces seemed to be used as outdoor living spaces where the participants would socialize, smoke, garden, and store additional items.

70% of the participants acknowledged their mobile home unit was manufactured during the 1970s, 10% of the participants acknowledged their mobile home unit was manufactured in the year 2007. All participants identified themselves as a homeowner who rents the lot. All participants are direct customers of electricity providers, and their homes are metered directly.



Survey results

Cooling down:

Half of the participants, 50%, utilize central air as a cooling equipment; 41.67% use window air conditioning; 8.3% use Portable A/C. During the summer all participants leave their cooling equipment on the same temperature all day. Participants indicated that their preferred temperature inside their home on average is 73F with minimum temperature of 61F and the highest temperature of 78F.

One third of the participants, 35.72%, acknowledged their mobile home unit has awnings, shade sails, or other shades that provide additional cooling. From our observation, most of the mobile home units had awnings on both sides of the mobile home unit. Also, 35.71% of participants acknowledged their mobile home lot has a yard with trees that provide additional shade. Half of the participants said they have some shade over their house from trees and/or shade structure, while 30% have a full shade and 20% have no shade.

Feeling hot inside mobile home:

One third of the participants, 30%, said that they feel hot inside their home sometimes, and 20% feel hot inside all the time. All participants experienced heat illness in the past two to five years. However, almost half of the participants, 44.44%, said that they do not have any heat-related pre-existing conditions that are exacerbated by the summer heat, while 33.33% have them. One of the main concerns during the summer season, 23.81% mentioned the potential health risks. Other concerns that were mentioned by 14.29% participants include inability financially afford utility cost, purchase and/or repair cooling equipment.



Survey results

Costs of heat exposure:

During the summer season, half of the participants sometimes feel forced to choose between paying for utility costs versus paying for other essential costs like home/lot rental payments, medical treatment and supplies, and food

In the most recent summer utility bills varies among all participants, In May, 2 participants paid between \$50 to \$100, and 4 participants paid between \$100 to \$200. In June, 3 participants paid between \$100 to \$200, 2 participants paid between \$200 to \$300, and 2 participants paid more than \$300. In July, 1 participant paid between \$50 to \$100. In August, 1 participant paid between \$100 to \$200.

Post-survey results:

During the second stage of the survey, participants did not mention any changes to their mobile homes. However, their preferred temperature inside their home have increased resulting in the minimum temperature of 74F and the highest temperature of 83F with the average of 67F. The estimated cost of electricity during the summer 2022 has also increased:

- In May 2022, 57% paid between \$50-\$100; 28% paid between \$100-\$200.
- In June 2022, 71% paid between \$100-\$200; 14% paid between \$50-\$100.
- In July 2022, 71% paid between \$100-\$200; 14% paid between \$50-\$100.
- In August 2022, 71% paid between \$100-\$200; 14% paid between \$50-\$100.



2022 Projects

Legislation analysis and results

Our law school team has been working closely with AAMHO to analyze the "Mobile Home Landlord & Tenant Act" (MHRPLTA) for updates that protect the right of mobile homeowners to utilize methods proven to protect against heat-related illnesses and death in their own homes. And in fact, our community partner the Arizona Housing Coalition has organized a workshop with Community Legal Services about the Mobile Home Landlord & Tenant Act.

Policy recommendations are aimed at protecting mobile home residents from heat-related harm. The first suggested change was an addition to A.R.S. 33-1434(A), which regulates a landlord's response to utility interruptions in a mobile home park. We proposed adding a section requiring mobile home park landlords to remedy any interruption of electrical service to tenants within four hours and if they are not successful in doing so, provide tenants with commercial-generated electrical power until power is restored.

The next proposal, also an addition to existing law, was to A.R.S. 33-1452(F). This proposed change would prohibit mobile home park landlords from preventing residents from using alternative cooling methods.

The final policy suggestion adds an entirely new section to the MHRPLTA. This added legislation would require park landlords to provide all tenants with a plan for sheltering and/or safe evacuation to a cooling center in times of severe heat. Additionally, mobile home park landlords would be required to provide tenants with a list of cooling stations or shelters to be used in case of an emergency (see the whole report in the Appendix).



Conference on Aging

KER was excited to host the Conference on Aging at the ASU Walton Center for Planetary Health main auditorium. Our guests from across the country gathered to learn how to build community-university partnerships that can help to identify and proactively respond to the challenges that the aging population across the entire country may face in the future.

Our goal was to share our insights and experiences through a seminar that showcased our ongoing community-university partnerships aimed at building community resilience to the shock of heat. The research narratives represented more than four years of knowledge exchange around heat resilience, particularly discovering together some of the hidden vulnerabilities among our older adult population who reside in mobile and manufactured housing. We have also developed solutions, which some of the partners have begun to mobilize.

The conference started with the presentation of our research narratives by Patricia Solis, Lora Philips, and Gail LaGrander, which gave a comprehensive understanding of discovering, analyzing, and solving the problem of heat exposure among mobile home residents in Maricopa County. Afterward, attendees enjoyed a community panel with Mary Alice Theroux, John Hoppin, Mary Wright, and Lauren Kuby, participating in the discussion to enhance heat resilience for mobile home residents.

See the Appendix for the research narrative and presentation slides.

Weatherization meeting at SRP

On December 6 we participated in Weatherization Peer-to-Peer Meeting where we presented our research on heat vulnerability of mobile homes residents with the goal to educate utility companies and seek opportunities for weatherization.

We have met with organizations who distribute weatherization funds in Arizona and discussed with them opportunities for weatherization of mobile homes.

We established new connections for the potential knowledge and data exchange for our research.





Recommendations & NEXT STEPS

Statewide Survey

The statewide survey “Heat Resilience in Mobile Homes” that ASU will conduct with AAMHO’s help in disseminating and aims to write an academic publication summarizing the results. This will allow KER to collect new, more comprehensive data crucial for ongoing research, advocacy, and policy recommendations.

Educate, collect data & build new partnerships

ASU will continue to seek opportunities to educate policy and decisionmakers in 2023 with the current data, and the statewide data, including finishing the map inventory to complete the state.

ASU will print more copies of the existing solutions guide upon demand.

Business Model for Solutions

Together with the LEAPS laboratory, we are looking to conduct a preliminary analysis on the economic viability of microgrid energy projects at mobile home parks, with the goal of writing a white paper to obtain funding to explore business models for community microgrids.

Finalize map inventory of mobile home parks

We aim to finalize and build a comprehensive database for all mobile home and mobile home park locations, representing a 4800 km² area within Arizona state.



Recommendations & NEXT STEPS

We recommend that AAMHO:

Use any info from this report to **inform** their members, constituents, as they see fit.

Consider how to **act** upon the recommendations from the legal analysis.

Provide any updates to our database inventory as needed.



Our Mission

The mission of the Knowledge Exchange for Resilience is to support Maricopa County, Arizona, by sharing knowledge, catalyzing discovery, and building solutions to catalyze change in order to build community resilience. We work to advance social cohesion, promote economic prosperity, and enhance environmental security to create profound and enduring change that brings resilience dividends.

We bring diverse stakeholders from across sectors together to share data, resources, and lived experiences. Our approach gives community partners a central role in driving the research process to identify vulnerabilities, uncover assets, and develop potential solutions.

We aim to build long-lasting partnerships to develop transformative solutions that enhance community resilience at a systems level. We are deeply committed to developing solutions and decision-making tools to increase the heat resilience of mobile home residents.

Research Publications

KER has written about mobile homes

Solís, P., Varfalameyeva, K., & Hernandez, C. A. (2022). “Heat resilience among mobile home owners in Arizona: Towards a multi-scale approach to address spatial incongruence and accountable decision making.” *GeoJournal*. In Publication.

Phillips, Lora A., Patricia Solís, Chuyuan Wang, Katsiaryna Varfalameyeva, and Janice Burnett. (2019). “Engaged Convergence Research: An Exploratory Approach to Heat Resilience in Mobile Homes.” *The Professional Geographer* 73(4): 619-631.

Varfalameyeva Katsiaryna, Patricia Solís, Lora A. Phillips, Elisha Charley, David M. Hondula, and Mark Kear. (2021). “Heat Mitigation Solutions Guide for Mobile Homes.” *Knowledge Exchange for Resilience Solutions Series*. Tempe: Arizona State University. <https://hdl.handle.net/2286/R.2.N.162992>

Sailor, D. J., Wentz, E., Anand, J., Alhazmi, M., Aguilar, E., Mehner, A. (2022, January 26). Avoided residential air conditioning energy costs associated with cooling the city: A case study for Phoenix Arizona USA [Symposium session]. *17th Symposium on Societal Applications: Policy, Research and Practice*, AMS 102nd Annual Meeting, Houston, TX, United States.

Varfalameyeva, Katsiaryna. (2020). “An illusion of affordability: the economic costs of heat exposure for mobile housing in the Phoenix Metropolitan Area.” *Master Thesis*. Arizona State University.

Solís Patricia, Katsiaryna Varfalameyeva, Lora A. Phillips, Elisha Charley. (2021). “Heat Resilience and Housing Assemblages: effects on home and well being among mobile home dwellers of Mesa, Arizona.” [Presentation] *American Association of Geographers Annual Meeting*.

Legislative Testimony:

Guardaro, Melissa (2022, August 23). “XX.” Housing Supply Study Committee, Arizona State Legislature.

Phillips, Lora A. (2022, August 23). “Housing in the Context of Extreme Heat.” Housing Supply Study Committee, Arizona State Legislature.

Media Coverage

Around heat exposure of mobile homes

Phillips, Lora A., Melissa Guardaro. (2022). “Mobile Homes Have a Major Climate Change Problem.” *Slate*. <http://bit.ly/3hxJvfS>

High Country News (2022, September 28). “You’re living in a tin can.” Print interview, Caroline Tracey. <https://bit.ly/3DcsYpa>

ABC 15 ARIZONA (2022, September 20). “Phoenix mobile home owners forced off land for development.” Television News interview, Ashley Holden. <https://bit.ly/3W9oacD>

FOX 10 Phoenix Local TV (2022, September 19). “Arizonans living in mobile or manufactured homes are at higher risk in the heat, research suggests.” Television News interview, Steve Nielsen. <https://bit.ly/3TZudi6>

CBS 5 Phoenix 3TV (2022, September 15). “Over one-third of heat-related indoor deaths occur in manufactured or mobile homes.” Television News interview, Alexis Dominguez. <bit.ly/cbs5heatsolis22>

KJZZ (2022, September 14). “Hot Town: Nearly 30% of metro Phoenix's heat-related deaths occur in manufactured homes.” Radio interview, Steve Goldstein, with Mark Kear. <https://bit.ly/3TGPLAd>

AZ Mirror (2022, August 24). “Arizona’s Housing Crisis Goes Hand-in-Hand with the State’s Water and Heat Crises.” Print interview, Gloria Rebecca Gomez. <https://bit.ly/3Dhacg3>

Knowledge Exchange for Resilience (2021, December 16). “Origins | A new model for building community resilience.” Don Newlen, and Drew Moraca, Fervor Creative. <bit.ly/heatmobilehomes>

Los Angeles Times (2021, October 28). “Poor neighborhoods bear the brunt of extreme heat, ‘legacies of racist decision-making.’” Print interview, Tony Barboza, with Ruben Vives. <https://lat.ms/3DbhzG5>

Washington Post (2021, July 2). “Extreme heat is killing people in Arizona’s mobile homes.” Print interview, Karen Peterson. <https://wapo.st/3fclQQo>

Media Coverage

Around heat exposure of mobile homes

PBS Terra (2021, June 7). “How America’s Hottest City is Innovating to Survive | Weathered.” Mayia May. bit.ly/hotttestusa

ABC 15 News (2021, April 23). “Arizona researchers look for ways to decrease heat deaths in trailers.” Television News interview, Courtney Holmes. bit.ly/abc15heat

Arizona Republic (2021, January 31). “Heat killed a record number of people in Arizona last year, ‘a staggering increase.’” Print interview, Ian James. <https://bit.ly/3DzS7vb>

High Country News (2020, September 1). “Extreme heat is here, and it’s deadly.” Print interview, Jessica Kutz. <https://bit.ly/3W5ZNfX>

National Geographic (2020, June 16). “As summer arrives, how will the most vulnerable escape deadly heat and COVID-19?” Print interview, Stephen Leahy. <https://on.natgeo.com/3SQnMx2>

AZ Mirror (2020, May 21). “Experts fear COVID-19 pandemic will lead to more summer heat deaths.” Print interview, Allison Stevens. <https://bit.ly/3DMYQ5j>

Los Angeles Times (2020, May 5). “Coronavirus could worsen death toll of summer heat waves, health officials warn.” Print interview, Anna M. Phillips, with Tony Barboza. <https://lat.ms/3sHiqsZ>

Arizona Republic (2020, May 3). “Self-isolating from COVID-19 in a mobile home? That could be deadly in Arizona”. Print interview, Mark Kear, Margaret Wilder, Patricia Solís, David Hondula, Mark Bernstein. <https://bit.ly/3TJDS7g>

New York Times (2019). “As Phoenix heats up, the night comes alive.” Print interview, Marguerite Holloway. <https://nyti.ms/3NbT6EW>



With Gratitude to our Joint Community and University Research Team

KER – Leadership and administration

- **Elizabeth Wentz**, Director
- **Patricia Solís**, Executive Director
- **Susana Bustillos**, Assistant Director
- **Marcia Nation**, Evaluator
- **Jamie Colburn**, Research Administrator
- **Travis Craddock**, Associate Director of Development

KER – faculty, staff and students

- **Melissa Guardaro**, Assistant Research Professor and Associate Director for Resilience Hubs
- **Giovanna Arenas**, Events Coordinator
- **Kate Varfalameyeva**, Research Specialist
- **Elisha Charley**, Graduate Research Assistant
- **Mason Mathews**, Assistant Research Professor and Associate Director for Academic Integration and Alliances
- **Sarbeswar Praharaj**, Assistant Research Professor and Associate Director for Data and Visualization
- **Lora Phillips**, Assistant Research Professor and Associate Director for Broader Impacts
- **Christina Hernandez**, Partnerships Manager
- **Abigail Johnson**, Communications Manager
- **Brajesh Karna**, Data Manager
- **Abdulrahman “AI” Alsanad**, GIS Analyst
- **Negar Rahmatollahi**, Graduate Research Assistant
- **Maryam Shafiee Shakib**, Graduate Research Assistant

AAMHO

- **Pat Schoneck**, President
- **Pat Sunia**, District 1 Director
- **John Hoppin**, District 2 Director
- **Connie Hancock**, Office Manager
- **Mary Alice Theroux**, Legislative Associate Director
- **Lee Goranson**
- Many other past board members and local member residents

KER – faculty, staff and students

- **Natalia da Silveira Arruda**, Graduate Research Assistant
- **Alexandria Drake**, Graduate Research Assistant
- **Kevin Jatin Vora**, Graduate Research Assistant
- **Joseph Karanja**, Graduate Research Assistant
- **Nishta Shah**, Research Assistant
- **Nicholas Kenney**, Research Aide
- **Claire Nelson**, Research Aide

ASU Departments and Centers

- **Chelsea Dickson**, Project Manager, Liaison to the Decision Theater
- **Shea Lemar**, Director, Geospatial Research & Solutions
- **James Ruberto**, Research Specialist, Geospatial Research and Solutions
- **Jenni Vanos**, Associate Professor, School of Sustainability
- **Di Bowman**, Professor, Sandra Day O'Connor College of Law
- **Bryan Hull**, Specialist, College of Law

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Appendix

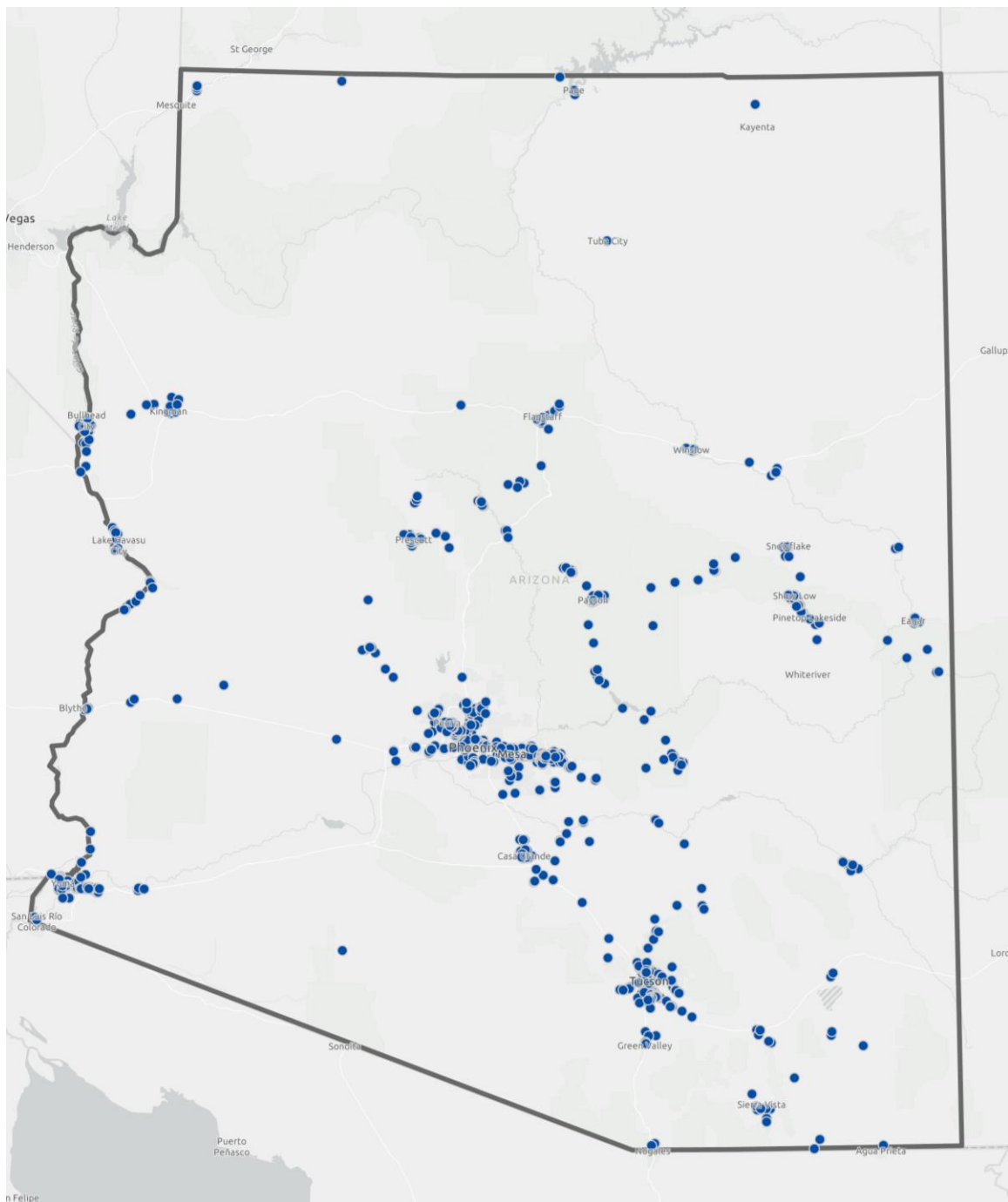
- 24** Statewide Mobile Home Park Development for Mapping/GIS
- 25** Indoor/Outdoor Heat Death by Age Group, 2006 – 2021
- 27** Map of mobile home parks within SRP and APS service areas
- 28** Map of mobile home parks vs Census Tracts with master meter buildings
- 29** Age by the cost of living alone – survey analysis
- 30** Mobile Home Pre and Follow-up Survey Analysis of mobile home residents
- 38** Detailed study updates from the meeting on August 8, 2022
- 50** Presentation slides from the meeting on September 19, 2022
- 70** An analysis of state legislation affecting mobile home resident
- 99** Conference on Aging - Research Narrative and presentation slides
- 150** An executive summary of the results of the 3M and SkyCool projects

Statewide Mobile Home Park Development for Mapping/GIS

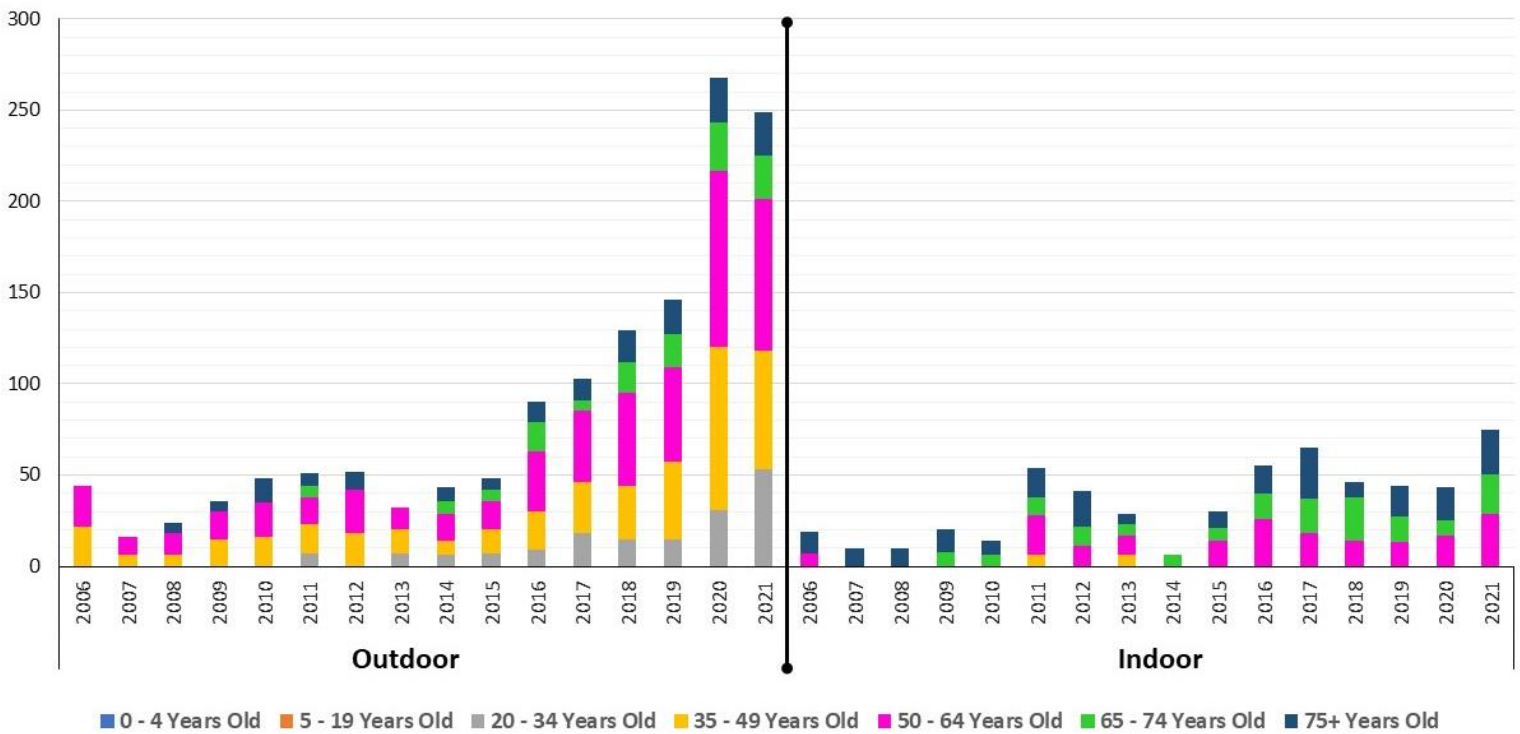
ASU's Geospatial Research & Solutions (GRS) is creating point level map/GIS data of Mobile Home Parks in Arizona. To our knowledge **no such source exists for the state of Arizona.**

Status:

- **1,043 total mobile home parks** in this AZ-wide dataset
- All **403 Maricopa County parks** have been **precisely located**
- Just under **300** parks throughout the rest of the state have been located and undergone the initial review stage
- ~ **375** parks await review



Indoor/Outdoor Heat Death by Age Group, 2006 – 2021

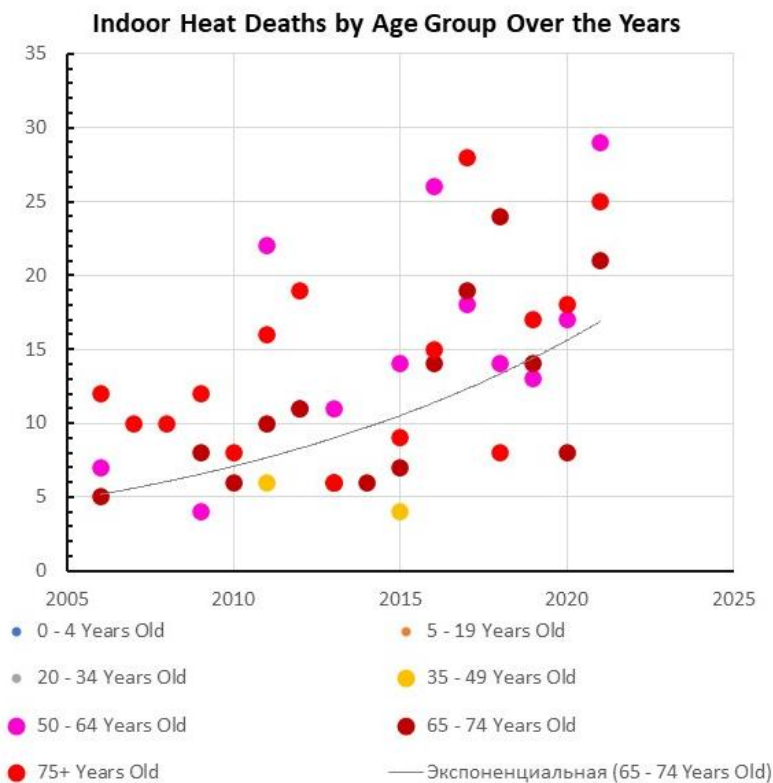
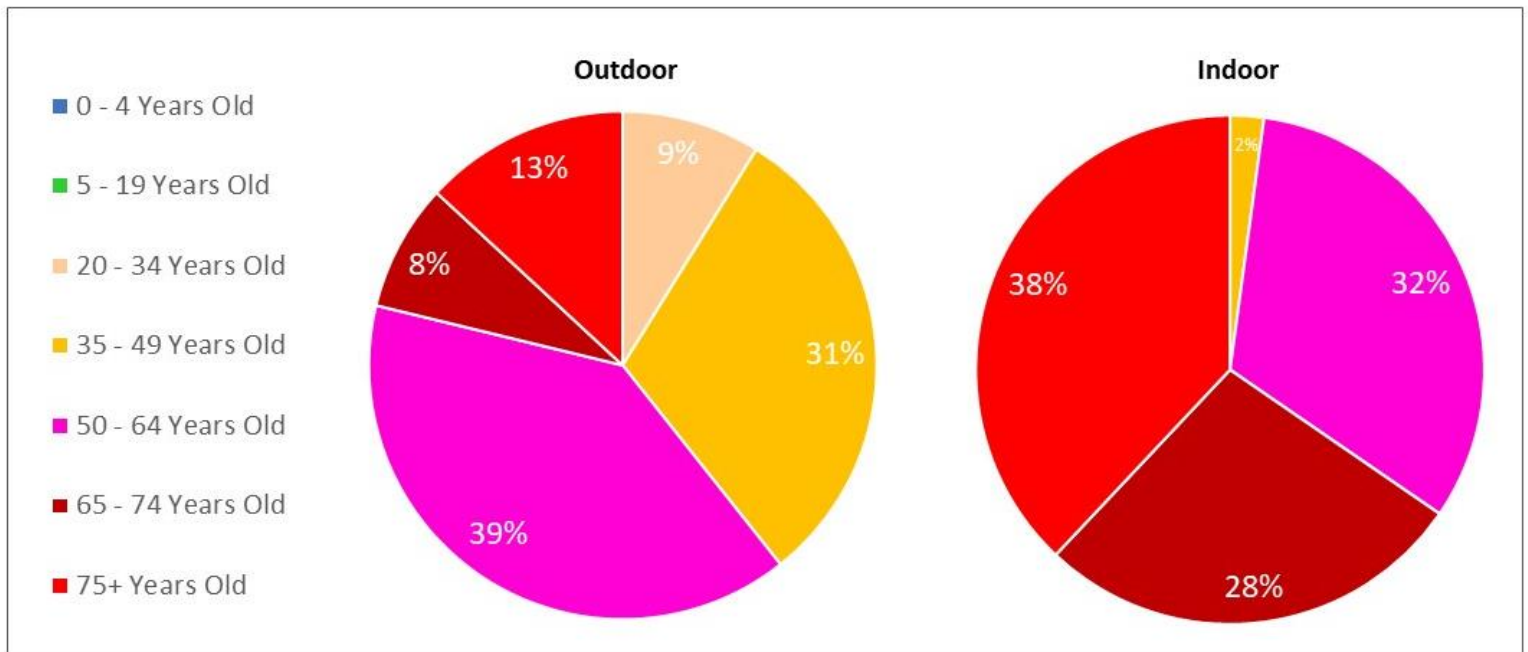


	Outdoor							Indoor						
	0 - 4	5 - 19	20 - 34	35 - 49	50 - 64	65 - 74	75+	0 - 4	5 - 19	20 - 34	35 - 49	50 - 64	65 - 74	75+
2006	*	*	*	22	22	*	*	*	*	*	*	7	*	12
2007	*	*	*	6	10	*	*	*	*	*	*	*	*	10
2008	*	*	*	6	12	*	6	*	*	*	*	*	*	10
2009	*	*	*	15	15	*	6	*	*	*	*	*	8	12
2010	*	*	*	16	19	*	13	*	*	*	*	*	6	8
2011	*	*	7	16	15	6	7	*	*	*	6	22	10	16
2012	*	*	*	18	24	*	10	*	*	*	*	11	11	19
2013	*	*	7	13	12	*	*	*	*	*	6	11	6	6
2014	*	*	6	8	15	7	7	*	*	*	*	*	6	*
2015	*	*	7	13	16	6	6	*	*	*	*	14	7	9
2016	*	*	9	21	33	16	11	*	*	*	*	26	14	15
2017	*	*	18	28	39	6	12	*	*	*	*	18	19	28
2018	*	*	15	29	51	17	17	*	*	*	*	14	24	8
2019	*	*	15	42	52	18	19	*	*	*	*	13	14	17
2020	*	*	31	89	97	26	25	*	*	*	*	17	8	18
2021	*	*	53	65	83	24	24	*	*	*	*	29	21	25

An * indicates that the count is 5 or less.

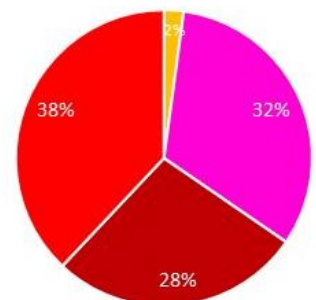
Maryam Shafiee Shakib

Indoor/Outdoor Heat Death by Age Group, 2006 – 2021



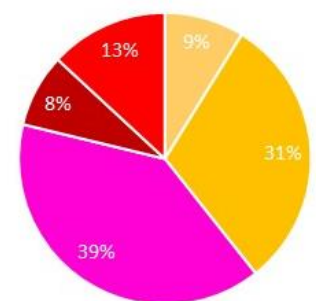
Indoor Heat Deaths by Age Group Over the Years 2006 - 2021

- 0 - 4 Years Old
- 5 - 19 Years Old
- 20 - 34 Years Old
- 35 - 49 Years Old
- 50 - 64 Years Old
- 65 - 74 Years Old
- 75+ Years Old



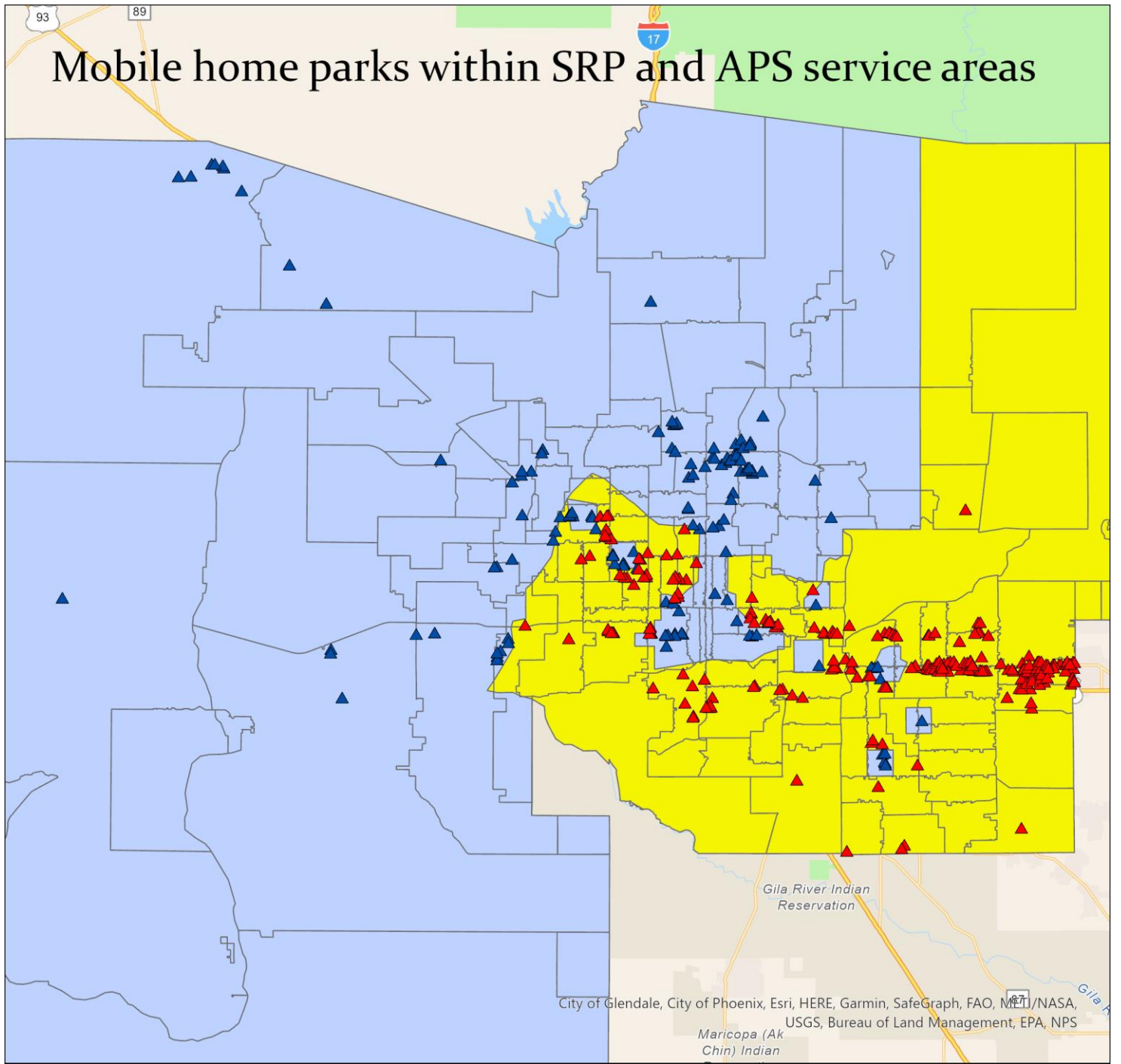
Outdoor Heat Deaths by Age Group Over the Years 2006 - 2021

- 0 - 4 Years Old
- 5 - 19 Years Old
- 20 - 34 Years Old
- 35 - 49 Years Old
- 50 - 64 Years Old
- 65 - 74 Years Old
- 75+ Years Old

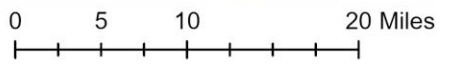


Maryam Shafiee Shakib

Mobile home parks within SRP and APS service areas



City of Glendale, City of Phoenix, Esri, HERE, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS
 Maricopa (Ak Chin) Indian



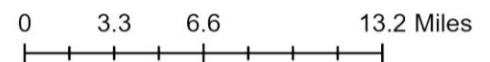
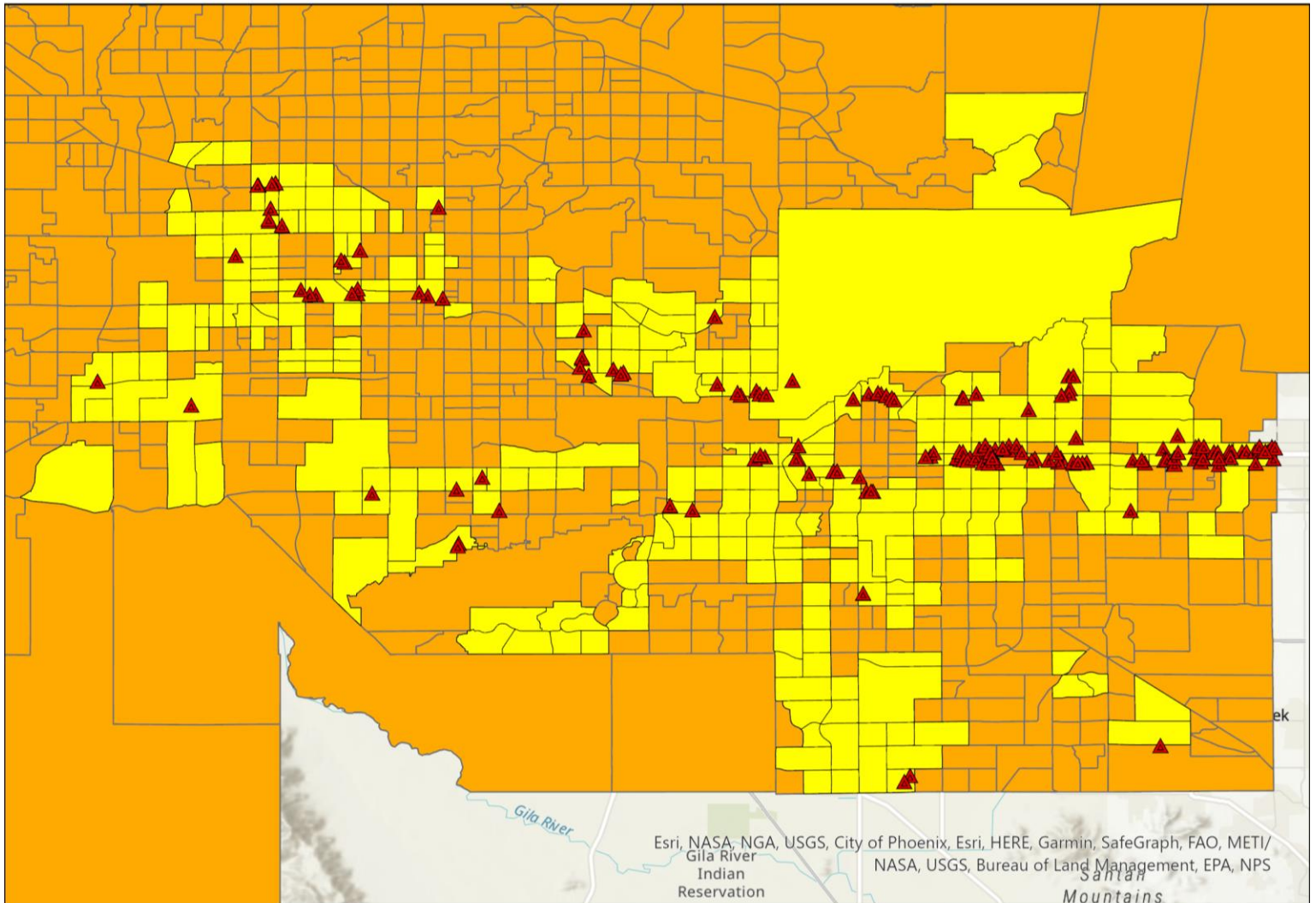
Legend

- ▲ 232 mobile home parks within SRP service area
 - ▲ 137 mobile home parks within APS service area
- SRP Service Area
 Number of parcels
 88
- APS Service Area
 Number of parcels
 137



Negar Rahmatollahi

Mobile Home Parks Vs. Census Tracts with Master Meter Buildings



Legend

- ▲ MHP = 161
- Census tracts with master meter buildings
- Maricopa County



Negar Rahmatollahi

Age by the cost of living alone – survey analysis

Participant ID#	Pre-Survey Count					Post-Survey Count			
	What type of cooling equipment do you utilize in your home	What is your age range	Employment status are you currently	What is your current marital status	What is the previous year's combined income of your household	What is the estimated cost of electricity during May?	What is the estimated cost of electricity during June?	What is the estimated cost of electricity during July?	What is the estimated cost of electricity during August?
1	Central air and window air conditioning	65 to 74 years	Retired	Single never married	\$50,000 to \$59,999	\$50 - \$100	\$100-\$200	\$100-\$200	\$100-\$200
2	Central air	55 to 64 years	Part-time employed for wages	Single never married	\$70,000 to \$79,999	\$50 - \$100	\$100-\$200	\$100-\$200	\$100-\$200
6	Window air conditioning two. Portable AC not in use.	75 to 84 years	Retired	Single never married	\$10,000 to \$19,999	\$100 - \$200	\$100-\$200	\$100-\$200	\$100-\$200
Count	66% Central air and or window air conditioning; 33% Window air conditioning.	33% 55-64 years; 33% 65-74 years; 33% 75-84 years	66% Retired; 33% part-time employed for wages	The response only listed "single never married." However, some of these participants were married and divorced. All three participants were single at the time of the survey.	33% of single mobile home participants have a household income of \$10,000 - \$19,999; 33% of single mobile home participants have a household income of \$50,000 - \$59,999; 33% of single mobile home participants have a household income of \$70,000 - \$79,999.	66% paid between \$50-\$100; 33% spent between \$100-\$200	100% paid between \$100-\$200	100% paid between \$100-\$200	100% paid between \$100-\$200
Analysis/ Theme	Most of the single mobile home participants have central air conditioning.	Age ranges vary.	Most of the single mobile home participants are retired.	Three single mobile home participants of a total of six counts.	Household income for single mobile home participants varies, with a small count. The one participant currently working a part-time job has the highest amount of income.	Most single mobile home participants pay an estimated \$50-\$100 for their electricity bill during May 2022.	All single mobile home participants paid an estimated \$100-\$200 for their electricity bill during June 2022.	All single mobile home participants paid an estimated \$100-\$200 for their electricity bill during July 2022.	All single mobile home participants paid an estimated \$100-\$200 for their electricity bill during August 2022.

Elisha Charley

ASU Knowledge Exchange Resilience

Mobile Home Pre and Follow-up Survey Analysis of mobile home residents

Introduction

The expanding extreme heat climate conditions in the Phoenix metropolitan area continue to impact Phoenixians, particularly mobile home (MH) residents. The research aims to understand the economic impact of heating the built environment of urban mobile home parks and mobile homes, as our prior research has identified them as highly vulnerable (Varfalameyeva et al., 2021; Phillips et al., 2021). Questions remain about the cost-benefit solutions, how are MH residents managing their energy use during the summer season? What are the varying utility burdens? How are mobile home residents adapting to extreme heat through cost-saving variables, DIY projects, and other adaptation means? The methods of understanding the research interests are to conduct a survey relating to mobile home heat impacts. The survey questions focus on how the residents manage summer heat utility bills and deal with the effects of the heat climate conditions. What are some of the mitigation measures for the summer season? We propose surveying MH residents about their experiences dealing with extreme heat in a mobile home.

In June 2022, our team focused on developing and administering survey questions relating to heat impacts, heat mitigations, and other restrictions that may hinder heat adaptations. We are fortunate to have an incredible team of collaborators and participants, including AAMHO and their subscribers, seven mobile home residents living in Mesa, AZ. The survey was conducted in two stages - pre and post. In the first stage, we had ten participants, however, in the second stage, we had six participants as some of them moved during the summer. We administered follow-up survey questions about heat impacts, mitigation, and other restrictions.

This report simply summarizes the findings and does not portend to present any analysis due to low response numbers. It does, however, serve as a test and inform our aims for a state-wide survey across all of Arizona that KER plans to conduct with support from AAMHO in 2023.

Mobile Home Pre-Survey Response

10 participants

Q2: What type of mobile/manufactured home do you currently live in?

90% live single-wide; 10% live in a double-wide.

Notes: Most of the participants lived in a single-wide mobile home trailer; however, the exterior facade of the units appeared doublewide, considering the built-on awning on either side of the mobile home unit. These awning structures varied in size and style most of the spaces seemed to be used as outdoor living spaces where the participants would socialize, smoke, garden, and store additional items.

Q3: What year was your mobile or manufactured home built?

1979

1972

1972

1971

1974

1972

1973

2007

1965

>10 years

Notes: 70% of the participants acknowledged their mobile home unit was manufactured during the 1970s. 10% of the participants acknowledged their mobile home unit was manufactured in the year 2007.

Q4: Do you rent or own your home, and do you rent or own the lot it sits on? Please choose the best option.

100% Identified as a homeowner and rent the lot.

Q5: For as long as your mobile/manufactured home has been at its current location, did the owner of the lot change?

50% Yes, the owner changed; 40% No, the owner did not change; 10% I don't know

Q6: In the past five years, have you ever faced an eviction?

100% No, I have not faced eviction in the past five years

Q7: Does your mobile/manufactured home move or is it in a stable, semi-permanent location?

90% My home does not move, and it is in the same location all year; 10% My home can move, but I do not move it throughout the year

Q8: Please indicate which months your home is located in Arizona (check all that apply)

0% no answers

Q9: Please indicate which months of the year you live in this home in Arizona (check all that apply)

0% no answers

Q10: In what type of setting is your mobile/manufactured home located in Arizona?

100% Urban or suburban park for mobile homes/trailers/RVs.

Q11: How long has your mobile/manufactured home been at its current location?

60% More than 10 years; 40% 1 to 3 years

Q 12: How do you receive electricity?

100% I am a direct customer, and my home is metered directly

Q 13: What type of building material is the roof of your mobile home made from?

50% Metal roofing (e.g., steel, aluminum, zinc, copper); 30% I don't know; 10% Asphalt shingles; 10% Other - Foam and metal

Q 14: How often do you have maintenance done to your roof? This includes activities such as cleaning or clearing debris or vegetation, installing a satellite dish, fixing leaks, etc.

40% Less frequently than every year; 20% A few times per year; 20% Never; 10% Annually; 10% More than once per month

Q 15: Who normally does this maintenance to your roof?

33.33% Someone I hire; 22.22% I do this myself; 22.22% Family who does not live in the home; 11.11% Someone else who lives in the home; 11.11% A neighbor

Q 16: What type of wall insulation does your mobile home have and what do you estimate is the thickness?

60% Batt or Roll Insulation (Consists of extremely fine glass fibers. R-values 3.1"-3.4" thickness); 20% I don't know; 10% Spray foam or Foam-in-place insulation; 10% Other - None

Q 17: What type of cooling equipment do you utilize in your home? (check all that apply)

50% Central air; 41.67% Window air conditioning; 8.3% Portable A/C

Q 18: How do you use your cooling equipment during the summer season? (check all that apply)

100% I leave it on the same temperature all day. The participants leave their air conditioning on at the same temperature all day. They do not change the temperature during the evenings, on rainy days, and during the winter season.

Q 19: During the summer season, what is your preferred temperature(s) in your home? (please use an approximate number)

Highest temp. 78F; Average temp. 73F; lowest temp. 61F.

Q 20: During the summer season, what temperature(s) do you tend to maintain in your home? (please use an approximate number)

Highest temp. 78F; Average temp. 73F; lowest temp. 61F.

Q 21: What days are you physically present in your home during WEEKDAYS (Monday-Friday)?

100% stay home Monday through Friday. All participants have acknowledged they stay home all day Monday through Friday, enjoying retirement or homecare obligations.

Q 22: What times of day are you normally physically present in the home on WEEKDAYS (Monday-Friday)?

80% stay home all day on weekdays; 10% stay home between 5 pm-8 am on weekdays; 10% of the participants travel between three doctor appointments on Weekdays. The majority (80%) of the participants stayed home all day on weekdays.

Q 23: What days are you physically present in your home during the WEEKENDS?

52.63% All day Saturday; 47.37% All day Sunday. All of the participants stay home most of the day, considering their retirement and homecare agendas.

Q 24: What times of day are you normally physically present in the home on Weekends (Saturday-Sunday)?

The majority of the participants (70%) are physically present in the home all day on the weekend. 10% of the participants often go to the clubhouse for dances, games, and movies during the weekend. 10% of the participants are physically present in the home during the morning and evenings on the weekends.

Q 25: What type of additional cooling features outdoors do you use? (check all that apply)

35.72% of the participants acknowledged their mobile home unit has awnings, shade sails, or other shades that provide additional cooling. From our observation, most of the mobile home units had awnings on both sides of the mobile home unit. 35.71% of participants acknowledged their mobile home lot has a yard with trees that provide additional shade. 14.29% of participants acknowledged their mobile home lot has a yard with grass that provides additional cooling. 7.14% of participants acknowledged they had misters or outdoor fans to provide additional cooling.

Q 24: How much shade does your house have over it (trees, shade structures, awning, etc.)?

50% Some shade; 30% Full shade; 20% No shade.

Q 25: What type of additional cooling features indoor do you use? (Check all that apply)

52.97% Floor or ceiling fan(s); 29.41% Shades or shutters; 11.76% Window fan(s); 5.88% Other, Insulated windows.

Q 26: Where do you go other than your home to cool off during the summer season? (check all that apply)

16.67% A facility like a clubhouse or the main building inside of my park; 16.67% Shopping malls or stores with AC; 16.67% Other, Movies, Not here during the summer months, Doctor offices/hospital, dialysis, and barber. Work and movie theater. Movie, restaurant, and brother's house; 13.33% A swimming pool; 10% Outside in a cooler patio or shaded area just outside my home; 10% friend's or family member's house; 6.67% A nearby park or outdoor shaded area; 6.67% I travel to somewhere outside of Phoenix; 3.33% I do not go anywhere else for purposes of staying cool.

Q 27: If you are elsewhere, how often is it necessary to leave your home to get cool?

62.50% Never; 37.50% Not often, once a month;

Q 28: What, if anything, limits you from leaving your home to go to places to cool off?

Kids; No A/C in the car; Health, not able to walk long distances; No car; None; None; None; None; No.

Q 29: Are you ever too hot inside your home during the summer?

30% Sometimes; 30% Never; 20% All the time; 10% Often; 10% Not often.

Q 30: What do you do when you feel too hot at home during the summer?

Go into an air-conditioned room; Baja AC; To cool room; Use a portable water fan, sit in front of the window air condition; Leave the home; Go to my daughter's pool; Turn the air condition down;

Eat a lot of popsicles, turn on the fan, and change clothes to be cooler; Turn the ceiling and floor fan on, kick the covers off.

Q 31: Have you ever experienced heat illness while living in your current home? (heat illness includes heat stroke, heat exhaustion, heat cramps, sunburn, and heat rash. Some symptoms of heat illness include high body temperature, hot, dry, and red skin, blisters on the skin, pale, cold, and clammy skin, headache, dizziness, nausea, and muscle cramps.)

81.82% Definitely not; 9.09% Definitely yes; 9.09% Please describe, kids (newborn) and Bathtub cooled.

Q 32: When was the most recent episode when you experienced heat illness?

100% In the previous two to five years

Q 33: Do you have any health-related pre-existing conditions that are exacerbated by the summer heat? (if so, please describe)

44.44% Definitely not; 33.33% Definitely yes; 11.11% Probably yes; 11.11% Might or might not.

Q 34: What are your heat-related concerns during the summer season? (please select all that apply)

23.81% The potential health risks; 14.29% I cannot financially afford utility cost; 14.29% I cannot financially afford to purchase cooling equipment; 14.29% I cannot financially afford to repair cooling equipment; 14.29% I worry about my family members/kids/neighbors/pets most; 9.52% Other, I can afford it but I don't want to pay for it; 4.76% I would like to weatherize my home but cannot financially afford to do so ; 4.76% I don't have many choices to escape the heat.

Q 35: During the summer season, how frequently do you feel forced to choose between paying for utility costs versus paying for other essential costs like home/lot rental payments, medical treatment and supplies, and food?

50% Sometimes; 40% Never; 10% Most of the time.

Q 36: Thinking about your bills from the most recent summer, when your mobile/manufactured home was located in Arizona, what did you pay for the cost of electricity during each of the following months?

May:

2 participants paid between \$50 to \$100; 4 participants paid between \$100 to \$200.

June:

3 participants paid between \$100 to \$200; 2 participants paid between \$200 to \$300; 2 participants paid more than \$300.

July:

1 participant paid between \$50 to \$100.

August:

1 participant paid between \$100 to \$200.

Q 37: Have you ever applied for utility assistance through your local power company?

60% No; 40% Yes.

Q 38: Do you currently receive any of the listed resources?

50% Other, 16.67% Food/nutrition assistance; 16.67% Utility assistance; 16.67% Clothing assistance.

Q 39: Which community/local resources do you obtain assistance from?

33.33% I don't receive any assistance; 22.22% Other; 11.11% Family, friends, or neighbors; 11.11% The State of Arizona government resources; 11.11% Church; 11.11% Foodbank.

Q 40: Which of the following solutions would you be willing to try to keep your living spaces in your mobile/manufactured home cool enough during the summer? (please assume that the individual solution would be allowed in your location)

50% Cooling film applied to the home rooftop to reduce temperature; 20% Shade trees; 10% High-efficiency air conditioning units; 10% Solar panels to reduce cost of electricity; 10% Weatherization to improve the insulation of my home.

Q 41: What barriers do you experience to adopting some of these solutions?

33.33% I don't know enough about what solutions are available; 33.33% Other reasons, please explain, Can't plant more trees, I don't own the lot, and solar panels not for mobile home roofs; 22.22% I cannot afford to pay for improvements to my home; 11.11% There are not enough financing options for me to make improvements.

Q 43: How many years have you lived in Arizona?

70% 11 years or more; 10% 1-5 years; 10% Less than 1 year; 10% I am not a full-time resident of Arizona

Q 44: What is your age range?

30% 75 to 84 years; 20% 55 to 64 years; 20% 65 to 74 years; 10% 35 to 44 years; 10% 85 to 94 years; 10% I prefer not to answer.

Q 45: Race (check all that apply)

60% White; 30% Hispanic, Latino, Mexican, Mexican-American, or Spanish; 10% Black or African American.

Q 46: Ethnicity

70% Not Hispanic/Latino/Chicano/Spanish; 30% Hispanic/Latino/Chicano/Spanish.

Q 47: Gender

60% Female; 40% Male

Q 48: What is the highest degree or level of school you have completed? If currently enrolled, the highest degree received

40% High School diploma, GED, or alternative credential; 30% Some college, no degree; 10% Less than 9th grade; 10% Trade school certificate; 10% Baccalaureate (e.g., BA, AB, BS).

Q 49: Employment Status, are you currently?

50% Retired; 20% Homemaker; 20% Part-time employed for wages; 10% Disabled.

Q 50: How often does your employer require you to work outside during the summer season?

44.44% Not employed; 33.33% Never, 11.11% Sometimes; 11.11% Other.

Q 51: What is your current marital status?

50% Married; 30% Single, never married; 20% Widowed.

Q 52: What is the previous year's combined income of your household?

40% \$10,000 to \$19,999; 20% \$30,000 to \$39,999; 10% \$50,000 to \$59,999; 10% \$20,000 to \$29,999.

Q 53: How many people are in your household?

40% Just me, one; 30% Two people; 20% Three to five; 10% More than five.

Q 54: Which best describes the composition of your household and its members?

50% Married-couple households; 40% Single-person households; 10% Family with children.

Q 55: Are there any members of your household who are limited in the kind or amount of activity that he/she can do because of a long-term physical condition, mental condition, or health problem

60% No, not limited; 40% Yes, limited.

ASU KER Mobile Home Follow-up Survey Analysis

6 participants total

Q 2: Since our last visit, has the owner of the mobile home park changed?

100% No, the owner did not change; 100% MH unit Ownership

Q 3: Since our last visit, have you installed any of the following roof materials on your mobile home?

71% None; 14% 3M radiative cooling film.

Q 4: During the most recent monsoon season, have you permitted any cleaning or clearing of debris or vegetation, installing, fixing leaks, a satellite dish, etc.?

71% No, Never; 14% More than once per month.

Q 5: Who did the maintenance to your roof?

71% None; 14% Blue Media.

Q 6: Since our last visit, what additional cooling equipment do you utilize in your home? (check all that apply)

100% None.

Q 7: Since our last visit, how often do you use your cooling equipment during summer? (check all that apply)

43% I leave it at the same temperature all day; 29% I adjust the temperature when I go to bed or when I am not home during the day. Most mobile home participants leave their thermostats at the same temperature all day.

Q 8: Since our last visit, have you changed the temperature(s) you tend to maintain in your home? (please use an approximate number)

8a.) Highest temp. 83F; Average temp. 67F; lowest temp. 74F

8b.) Highest temp. 83F; Average temp. 67F; lowest temp. 74F

8c.) Highest temp. 78F; Average temp. 65F; lowest temp. 74F

Q 9: Since our last visit have you applied any of the listed objects for additional cooling features outdoors, do you use? (check all that apply)

100% None.

Q 10: Since our last visit, have you added any additional cooling features indoors? (Check all that apply)

85% None; 14% New ceiling fan.

Q 11: Have you changed your routine or methods of where to visit to cool off during the summer season? (check all that apply)

100% No.

Q 12: Has your heat-related concerns during the summer season changed? (please select all that apply)

50% No; 33% I cannot afford utility costs; 16% I worry about my family members/kids/neighbors/pets most.

Q 13: What is the estimated cost of electricity during each of the following months?

May 2022

57% paid between \$50-\$100; 28% paid between \$100-\$200.

June 2022

71% paid between \$100-\$200; 14% paid between \$50-\$100.

July 2022

71% paid between \$100-\$200; 14% paid between \$50-\$100.

August 2022

71% paid between \$100-\$200; 14% paid between \$50-\$100.

Q 14: Since our last visit, have you installed any of the listed items below:

83% None; 16% radiative cooling film has been applied to a home rooftop to reduce the temperature.

Q 15: Since our last visit, have you ever experienced heat illness while living in your current home? (heat illness includes heat stroke, heat exhaustion, heat cramps, sunburn, and heat rash. Some symptoms of heat illness include high body temperature, hot, dry, red skin, blisters on the skin, pale, cold, clammy skin, headache, dizziness, nausea, and muscle cramps.)

83% Definitely not; 16% Probably yes.

Q 16: Do you have any pre-existing health-related conditions exacerbated by the summer heat? (if so, please describe)

66% Definitely, not; 33% probably yes.

STUDY UPDATE: MOBILE HOME RESIDENTS IN ARIZONA

August 2022

Legislative Analysis

By Di Bowman, Brian Hull, and Patricia Solís

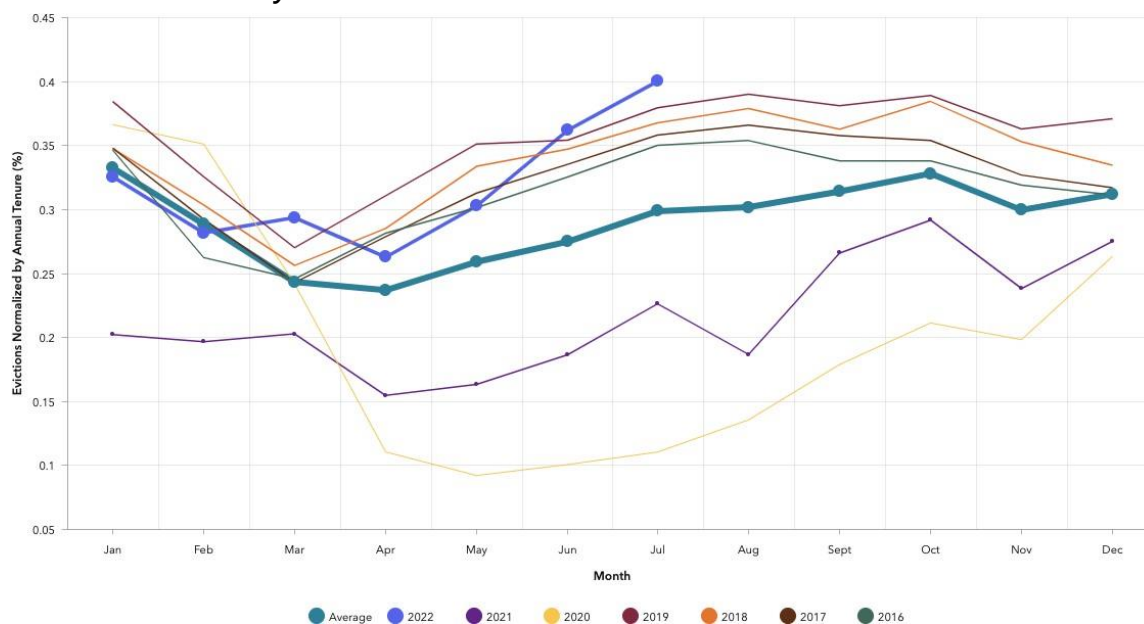
The objective of reviewing the current Landlord Tenant Act and suggesting edits and policy recommendations remains a major focus for the team. This will include taking findings from all of our joint activities, from evictions data to heat, and in the past weeks a set of mark-ups has been circulating. This past week, we received additional suggestions from AAMHO (Mary Alice) which are being incorporated now. The final document will take the form of a “legal commentary” led by Dr. Bowman. We expect a few more rounds back and forth, a broad team readout, and finalization soon.

Eviction Trends

By Patricia Solis, Lora Philips, Shea Lemar, James Ruberto and Sandeep Sabu

We received the official evictions tabulation for the most recent month from the courts yesterday to see that July 2022 has a higher one-month number than any time since the 2008 housing crisis. The fact that this surge is happening in the middle of the hot summer is an added concern (Figure 1).

Eviction Trends by Month and Year 2016 – 2022



Source: KER; Geospatial Research & Solutions; Maricopa County Justice Courts

We have updated our evictions dashboard at <https://resilience.asu.edu/evictions-dashboard>. We reached out to the Maricopa Association of Governments to understand where we could converse about these trends, and the Deputy Director responded that she agrees this overall trend is very concerning. She furthermore shared that if more data were available about who received assistance or not, and those who were evicted, then we could better understand the saturation and impact of assistance in the community. None of us are confident about receiving that data nor that modeling is possible right now.

We were curious about breaking out the locations of evictions where we know mobile homes are sited, in order to try to estimate to what extent this spike is affecting mobile home residents. According to our quick analysis, the increase in the rate of evictions at MHPs is definitely rising, but not as fast as the increase in the rate of evictions for the county overall. Using a simple methodology of developing a parcels layer where MHP intersected a parcel, we estimate:

- In July 2021, there were 41/343 MHP parcels that had evictions, and there were a total of 73 evictions.
- In July 2022, there were 51/343 MHP parcels that had evictions, and there were a total of 105 evictions.
- The percent increase of parcels from 41 to 51 is 24.4%, and the percent increase in total evictions on those parcels of 73 to 105 is 43.8%.
- The jump in total evictions for all of the county between the two datasets is from 3499 to 6406, an 83.1% increase.

We can conclude that there is a growing concern about evictions for mobile home residents, and all residents alike.

Utility Affordability

By Carlos Aguiar Hernandez

Following KER investigation about whether mobile home residents could afford their utility bill, we did analysis on Household Pulse Survey. The experimental Household Pulse Survey is designed by census bureau to quickly and efficiently deploy data collected on how people's lives have been impacted during the coronavirus pandemic. We estimate the difference between mobile homes and other building types in their capacity to pay energy bills.

“The results show that, on average, people living in mobile homes in Arizona are twice more likely to reduce or forego expenses for basic household necessities, such as medicine or food, to pay their energy bills. 10.73% of mobile home dwellings were troubled paying their energy bills almost every month in the last 12 months; 5.37% of other building types experienced this reduction.”

Mapping Inventory

By Maryam Shakib, Shea Lemar, and James Ruberto

In the last month, we have had correspondence with mapping organizations to accelerate launching of “mobile home mapping project”. We have provided informative material required for our YouthMappers community to introduce mobile home project and how they could use the MapSwipe app to verify and spot the lost mobile home parks across the state. We are planning to have a campaign in near future with collaboration of the British red cross and MapSwipe which is a part of Missing Map organization to technically support YouthMappers in mapping project.

At the same time, our GIS team has been working on the various segregated data sources of mobile home boundaries to combine them as a unit exclusionary repository for mobile home parks. Currently our data source for mobile home parks within Maricopa County is ready to use. We are still looking for any material that could pinpoint additional mobile homes within Arizona.

Heat Solutions

By Elisha Charley and Nicholas Kenney

In the month of June 2022, our team focused on developing and administering survey questions relating to heat impacts, heat mitigations, and other restrictions that may hinder heat adaptations. We are fortunate to have an incredible team of collaborators and participants including AAMHO and their subscribers. We surveyed seven mobile home residents living in Mesa, AZ. We are currently analyzing the survey data and working on developing a report of the final analysis. Our analysis process will provide a better understanding of current heat impacts and possibly unknown factors. In addition, it will provide support for any follow-up questions we may have in the future.

The second part of our research efforts is to understand the indoor temperatures and roof temperatures of mobile homes during the hottest months of the summer. We successfully installed iButtons (heat logging sensors) inside and outside the seven participants' mobile homes. This will allow our team to document real-time indoor temperatures throughout the day, every day for three months. We plan to collect the iButtons at the end of August to begin our data analysis process for each mobile home unit. In addition to our visit in August, we will administer follow-up survey questions relating to heat impacts, heat mitigation, and other restrictions.

The third part of our research project is to collaborate with a third-party sector including 3M, Sky Cool, and most importantly mobile home participants. This process is to test a product in development that may provide heat reflective support on mobile home roofs. We have attempted to install the heat reflective film, however, there have been some

delays due to the roof conditions, adhesive failures, and weather conditions. We are waiting for a future installation date that is safe for the construction team to install the heat reflective film.

Roof Cleaning and First Attempt at Installation of Heat Reflective Film



Source: Knowledge Exchange for Resilience; E. Charley

AAMHO Calls Summary

By Claire Nelson and Lora Philips

We are working with our law team to write up a briefing paper that summarizes the findings from our analysis of calls for assistance and provides legal recommendations related to these findings. Once a first draft is completed, we would love to get feedback from AAMHO and include any recommendations that AAMHO would offer in the final document. We would also like to include AAMHO as an author. This briefing paper will be uploaded to the ASU library repository so that I can be searched for, forwarded, and cited as needed.

In September, Lora will start exploring mobile home park ownership, ownership changes, and evictions using data from the Maricopa County Justice Courts and Maricopa County Assessor's Office.

Complaint Fact Sheet

By Di bowman and Brian Hull

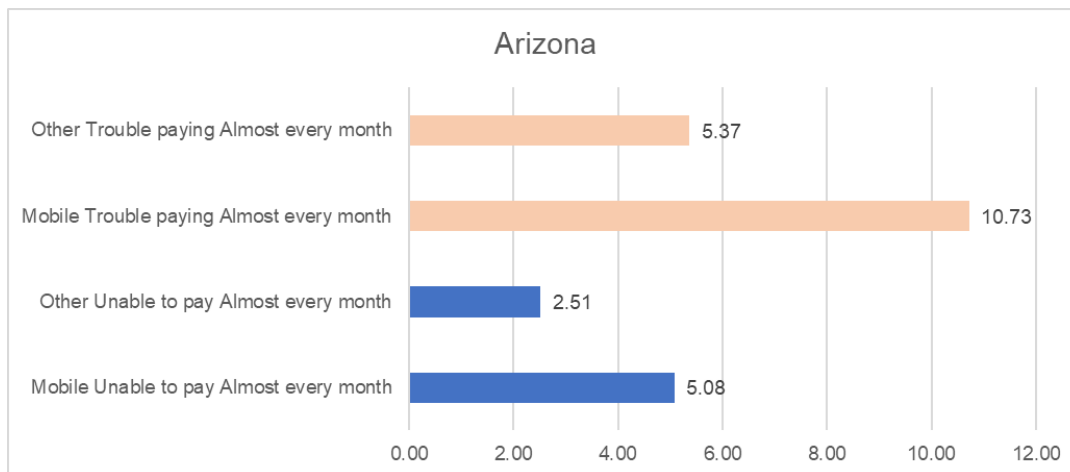
Another focus for the law school crew has been to continue to flesh out the complaints data and working on the "complaint fact sheet". Drafts of this compilation have been provided in prior meetings. This is also informing the legal commentary and analysis.

Household Pulse Survey United States Census Bureau

From week 34 (July 21, 2021 -August 2, 2021) to week 47 (June 29, 2022 – July 11, 2022), the Household Pulse Survey applied 24,155 surveys in Arizona; 20,479 after removing missing and did not report. This analysis uses the weeks mentioned above because they include the following questions:

- In the last 12 months, how many months did your household reduce or forego expenses for basic household necessities, such as medicine or food, in order to pay an energy bill?
- In the last 12 months, how many times was your household unable to pay an energy bill or unable to pay the full bill amount?
-

The results show that, on average, people living in mobile homes in Arizona are twice more likely to reduce or forego expenses for basic household necessities, such as medicine or food, to pay their energy bills. 10.73% of mobile home dwellings were troubled paying their energy bills almost every month in the last 12 months; 5.37% of other building types experienced this reduction. Comparing mobile homes with other building types, the former are unable to pay an energy bill or unable to pay the full bill amount in 5.08% of the cases, the latter in 2.51%. Figure 1 presents the results of these two questions regarding the category “Almost every month”, reflecting how mobile homes struggle to pay energy bills in Arizona compared to the rest of the building types.



Comparison between mobile homes and other building types, trouble and unable to pay energy bills almost every month in the last 12 months.

People living in mobile homes in Arizona are almost three times more likely to have an income of fewer than 25,000 USD per year compared with other building types; nearly 30% of mobile home income is less than 25,000 USD per year.

Table 1

Results of the questions mentioned above, income (less than 25,000 USD per year), and living alone.

Week	Mobile Unable to pay Almost every month	Other Unable to pay Almost every month	Mobile Trouble paying Almost every month	Other Trouble paying Almost every month	Mobile less than 25K	Other less than 25K	Mobile living alone	Other living alone
34	5	3.09	3.33	5.57	30	9.44	33.33	18.79
35	4.62	2.57	6.15	4.45	21.54	10.99	26.15	18.43
36	3.28	2.17	14.75	5.87	21.31	7.83	24.59	18.25
37	7.45	2.55	12.77	4.38	28.72	9.07	29.79	18.3
38	1.96	2.92	7.84	4.54	33.33	9.08	27.45	20.1
39	3.17	2.18	11.11	5.49	30.16	8.72	26.98	16.56
40	6.02	2.64	6.02	5.28	34.94	9.74	27.71	19.77
41	6.58	2.92	7.89	5.48	32.89	8.58	28.95	19.29
42	5.77	2.59	14.42	5.48	31.73	10	28.85	18.86
43	1.18	2.76	10.59	6.43	18.82	10.68	29.41	19.12
44	4.3	1.7	13.98	4.4	32.26	10.88	34.41	18.75
45	6.25	1.69	10	4.83	26.25	10.8	28.75	19.92
46	8.14	2.05	15.12	6.24	32.56	9.76	31.4	20.03
47	7.35	3.37	16.18	6.73	23.53	8.54	23.53	19.26
Average	5.08	2.51	10.73	5.37	28.43	9.58	28.66	18.96

Note: All results are expressed as percentages and include all surveys in Arizona for each week.

Join YouthMappers using MapSwipe to support Heat Resilience among Mobile Home Residents

According to the CDC, more people die in the U.S. from heat than from all other natural disasters combined. Although only 5% of housing in Maricopa County of Arizona is mobile and manufactured homes, approximately 30% of indoor heat-related deaths occur inside this type of home. This means they are 6 times more likely to die of heat because of where they live. People may live in mobile homes because it is a housing option to own their a home and is far more affordable than other alternatives. But livability in such dwellings depends on continued resilience to the Arizona heat. Many older mobile homes are not well insulated and some owners tend to have lower incomes or are senior citizens on fixed incomes, all factors that make mobile homeowners more vulnerable to heat compared to people living in any other type of housing.

Despite that our research team at ASU has been studying this problem for the past four years, there remains a lack of reliable and thorough data on exactly where are all of the mobile homes and mobile home park locations throughout the state. There has been insufficient data to assess the quality of life and basic service conditions in mobile homes compared to conditions in other housing types. While manufactured housing and RV parks represent a robust section of the community's housing market, there is not a comprehensive and accurate database available to demonstrate their location among other land uses. They are falling between the cracks of assistance required to tackle heat-related morbidity and mortality because they are neglected in zoning resolutions, in practice and fundamental spatial data is.

In our continuous effort to map these communities, we have found more than 900 mobile home parks in the state in various incomplete datasets and derivative sources. However, our quality checks confirm that we are missing a lot of locations, including knowing how many units are present in the state. Due to this lack of a comprehensive geographical data source, confounded by a large scale of the study area across all of Arizona, we need your help. We have called upon YouthMappers- an international university consortium on Mapping for Resilience- assistance to increase our mapping capacity to find the places we are missing.

To get a bird's eye view of all mobile homes and parks across Arizona state, we are teaming up with MapSwipe as an open-source app to facilitate providing coordinated and efficient maps and data and YouthMappers and friends to crowdsource information. MapSwipe is part of the Missing Maps Project with large support from the British Red Cross, HeiGIT, Humanitarian OpenStreetMap Team, Medecins Sans Frontiers (Doctors without Borders) organisations mapping around the world particularly for vulnerable communities. In this mobile home project on MapSwipe, YouthMappers swipe through satellite images looking for mobile home parks to spot them on map. Together we will be able to find our residents who are the most vulnerable to heat, and bring more resilient solutions to those who are falling between the cracks.

For more information about mobile homes, see [Mobile Home Tutorial](#).

For more information about MapSwipe: www.mapswipe.org

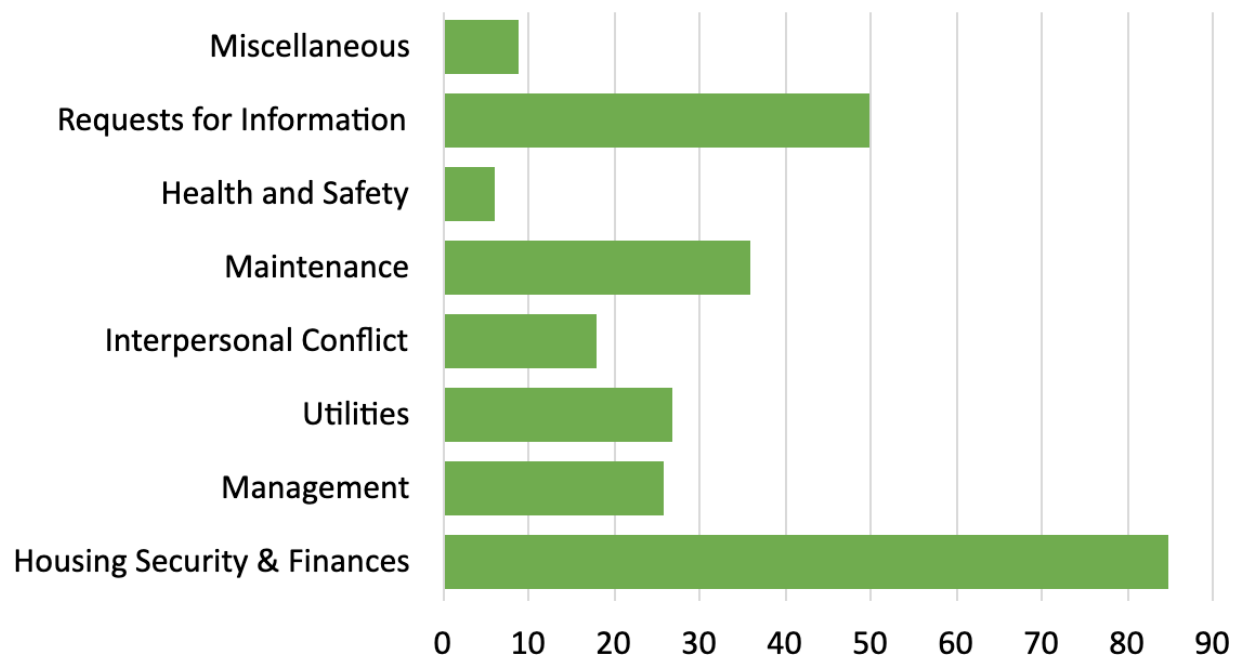
For more information about YouthMappers: www.youthmappers.org



AAMHO Calls Summary Data

210 calls were made to AAMHO over a period of 9 months (June 1, 2021 - May 19, 2022). These calls were sorted into eight complaint categories and more detailed sub-categories. Some calls were placed in multiple categories if the criteria for each category was met. The criteria for these categories can be found in the following pages alongside a complete count of calls in each category.

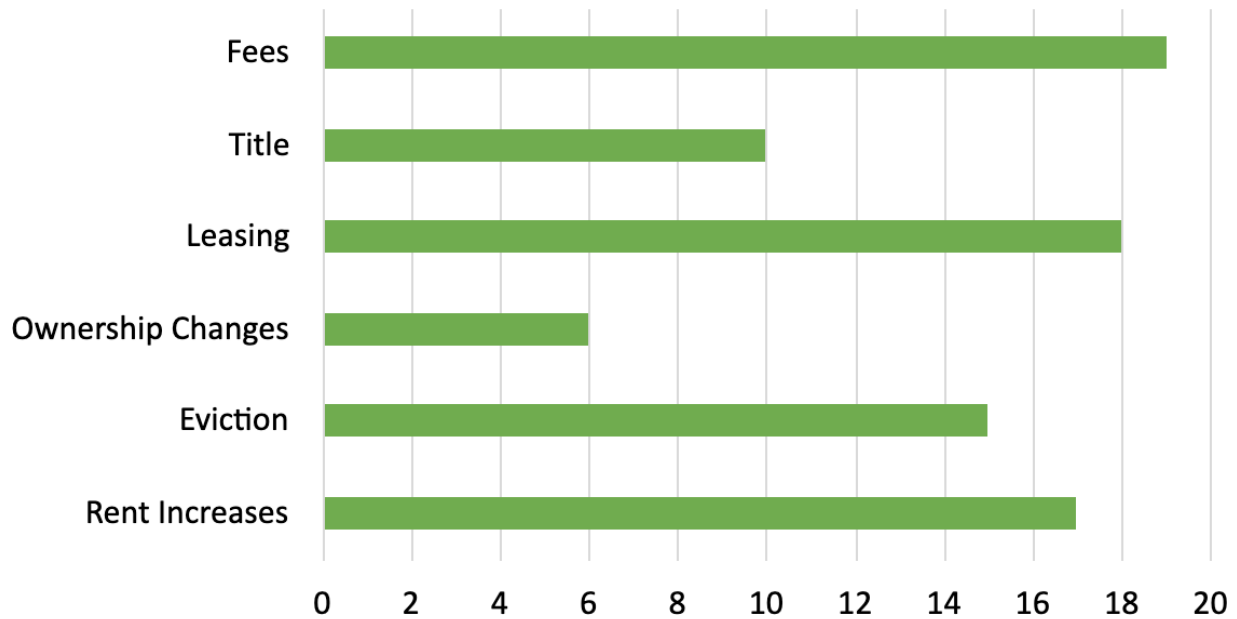
AAMHO Complaints by Category



Graph displaying the count for the eight main categories.

The graph above shows that mobile home residents are very concerned about Housing Security and Finances. The next largest category after Housing Security and Finances is Requests for information (which are questions directed to AAMHO) and Maintenance. Requests for information are commonly placed in another category which represents the subject of the question.

Housing Security and Finances



Graph displaying count of the subcategories of Housing Security and Finances.

Within the Housing Security and Finances category, Residents are concerned about Fees, Leasing, Rent Increases, and Eviction.

Location Analysis

Calls were made from 123 individual parks, 16 of which we were not able to find locations due to a lack of information or clerical error. The vast majority of parks only had one caller from that park. 7 callers did not provide the location of their Mobile Home or RV Park.

The most mentioned Parks were:

Agave Village (8)

Tempe Cascades (7)

Contempo Tempe (7)

Rincon Country (5)

AAMHO Complaint Categories

1. Housing Security & Finances

- a. Rent Increases
- b. Eviction
- c. Ownership changes/Park Sale
- d. Leasing: issues regarding leasing, including new leases
- e. Title: issues with title or restrictions on selling home
- f. Fees or Overcharges: fees for maintenance, late rent, etc

2. Management

- a. General
- b. Rules: includes rule changes and inconsistent enforcement of policy
- c. Property Owner: issues with the park owner directly

3. Utilities

- a. Metering & Billing: issues related to the metering and billing of water, electricity or sewage
- b. Outages, Maintenance, etc: utility outages or neglected maintenance

4. Interpersonal Conflict

- a. Discrimination
- b. Harassment: harassment by neighbors or park management
- c. Domestic Disputes
- d. Age Limits: complaints about or violations of age limits for park
- e. Pets

5. Maintenance

- a. General: general complaints about maintenance
- b. Facilities Upkeep: maintenance issues regarding common areas, shared facilities, and amenities. This includes everything from pools and other community spaces to streets and street lights.
- c. Landscaping: trees and other landscaping
- d. Infestation

6. Health and Safety

- a. Caregivers: includes issues regarding caregivers, does not denote if a caregiver is acting on behalf of a mobile home owner
- b. Disability or ADA violations
- c. Crime
- d. Other: other health and safety violations including environmental hazards and building code violations

7. Requests for Information

- a. General: general questions about the LTA, rules and regulations, etc. This code is commonly partnered with another code representing the content of the question asked
- b. AAMHO: requests for AAMHO-specific services, including educational materials, site visits, AAMHO representation, meetings, complaints, etc. and general questions about the organization

8. Miscellaneous: requests that fit in no other category

Housing Security and Financial Concerns	
Rent Increases	17
Eviction	15
Ownership Changes	6
Leasing	18
Title	10
Fees	19
Total	85

Utilities	
Metering & Billing	17
Outages & Maintenance	10
Total	27

Maintenance	
General	12
Facilities	8
Landscaping	13
Infestation	3
Total	36

Requests for information	
General	27
AAMHO	23
Total	50

Management	
General	17
Rules	8
Property Owner	1
Total	26

Interpersonal Conflict	
Discrimination	2
Harassment	3
Domestic Disputes	1
Age Limits	5
Pets	7
Total	18

Health and Safety	
Caregivers	2
ADA	1
Crime	1
Other	2
Total	6

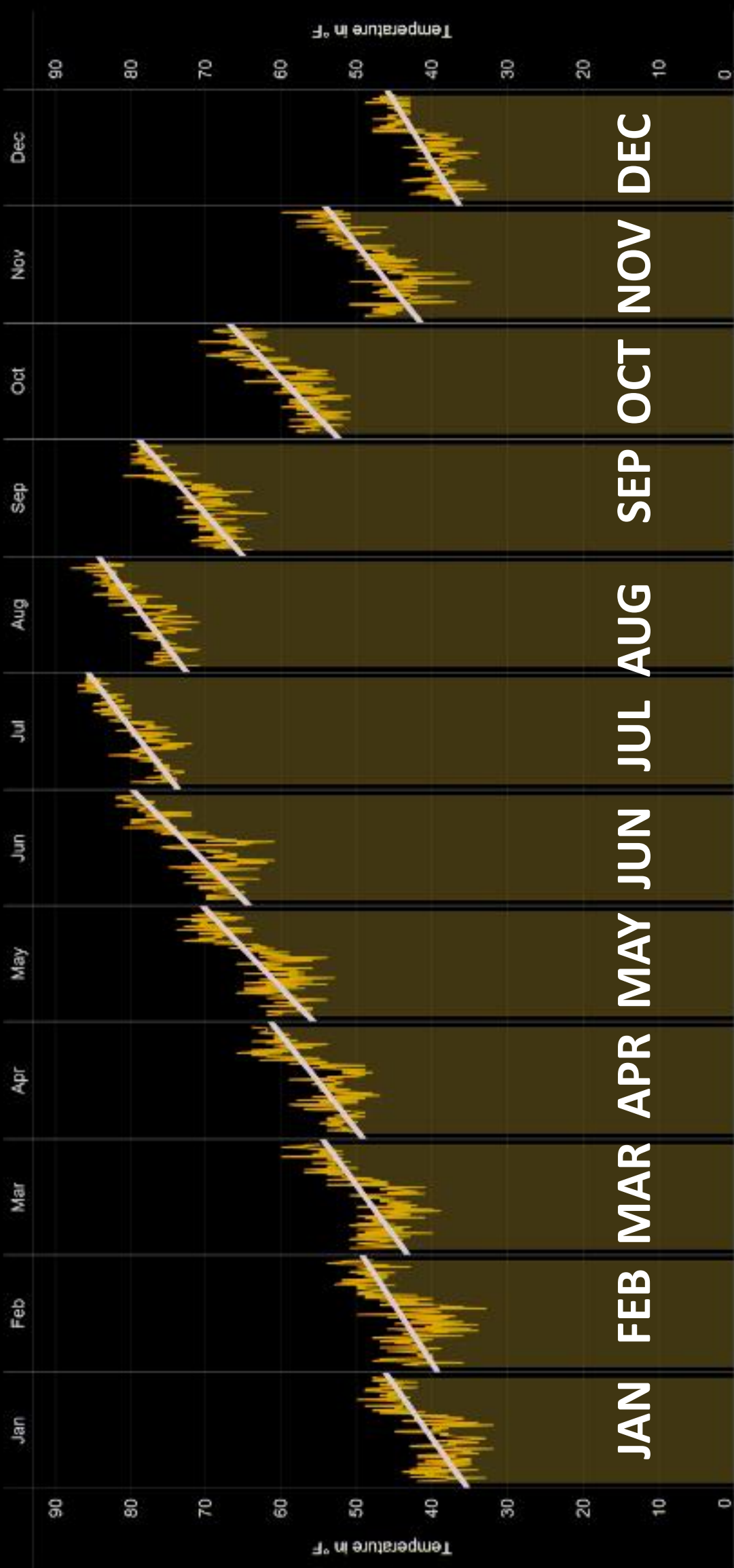
Miscellaneous	
	9

Total*	210
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*210 Calls were made over this time period but many were filtered into multiple categories.

Presentation slides from the meeting on September 19, 2022

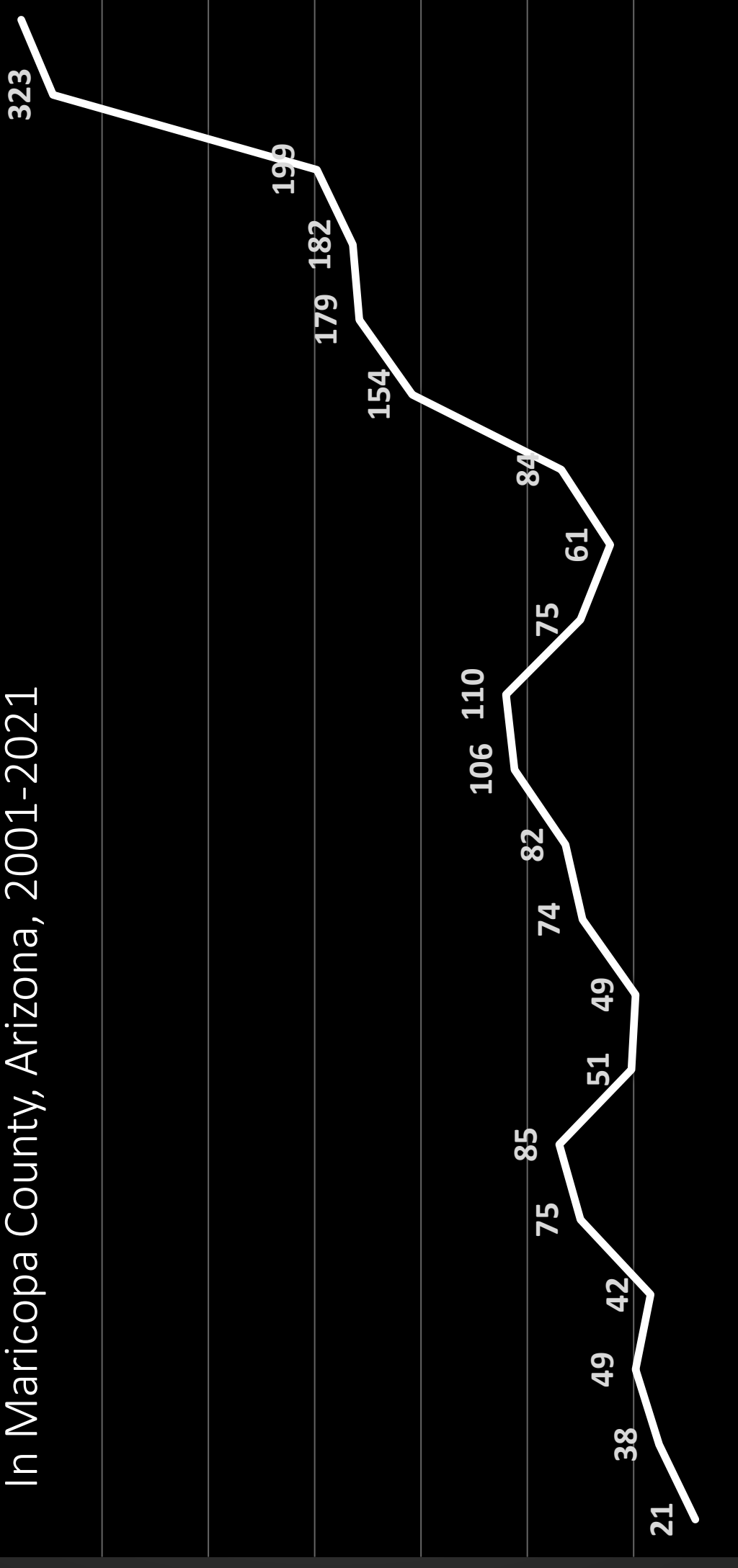
Phoenix Monthly Minimum Temperature 1900-2018, by month



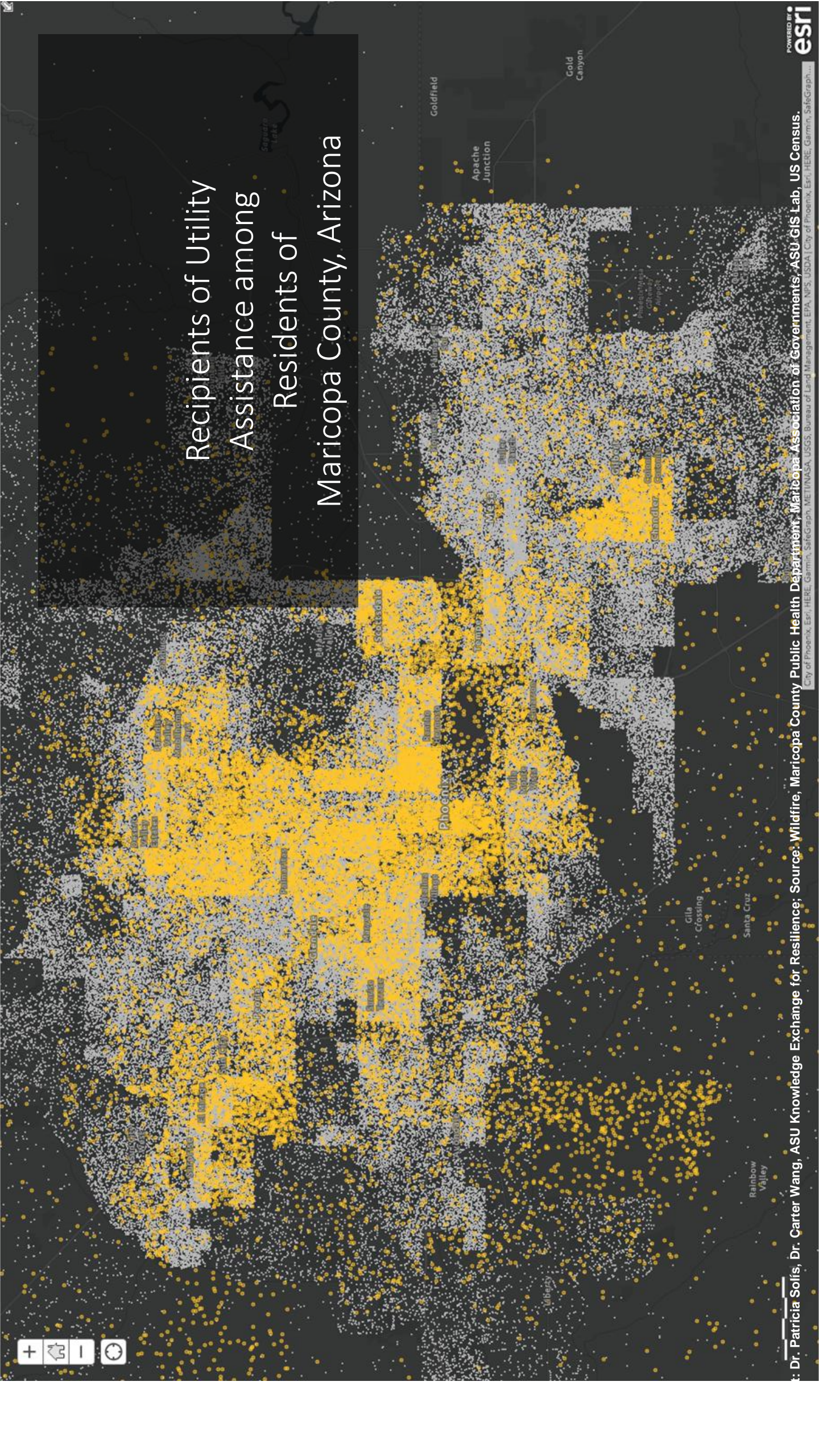
Heat-Associated Deaths by Year

339

In Maricopa County, Arizona, 2001-2021

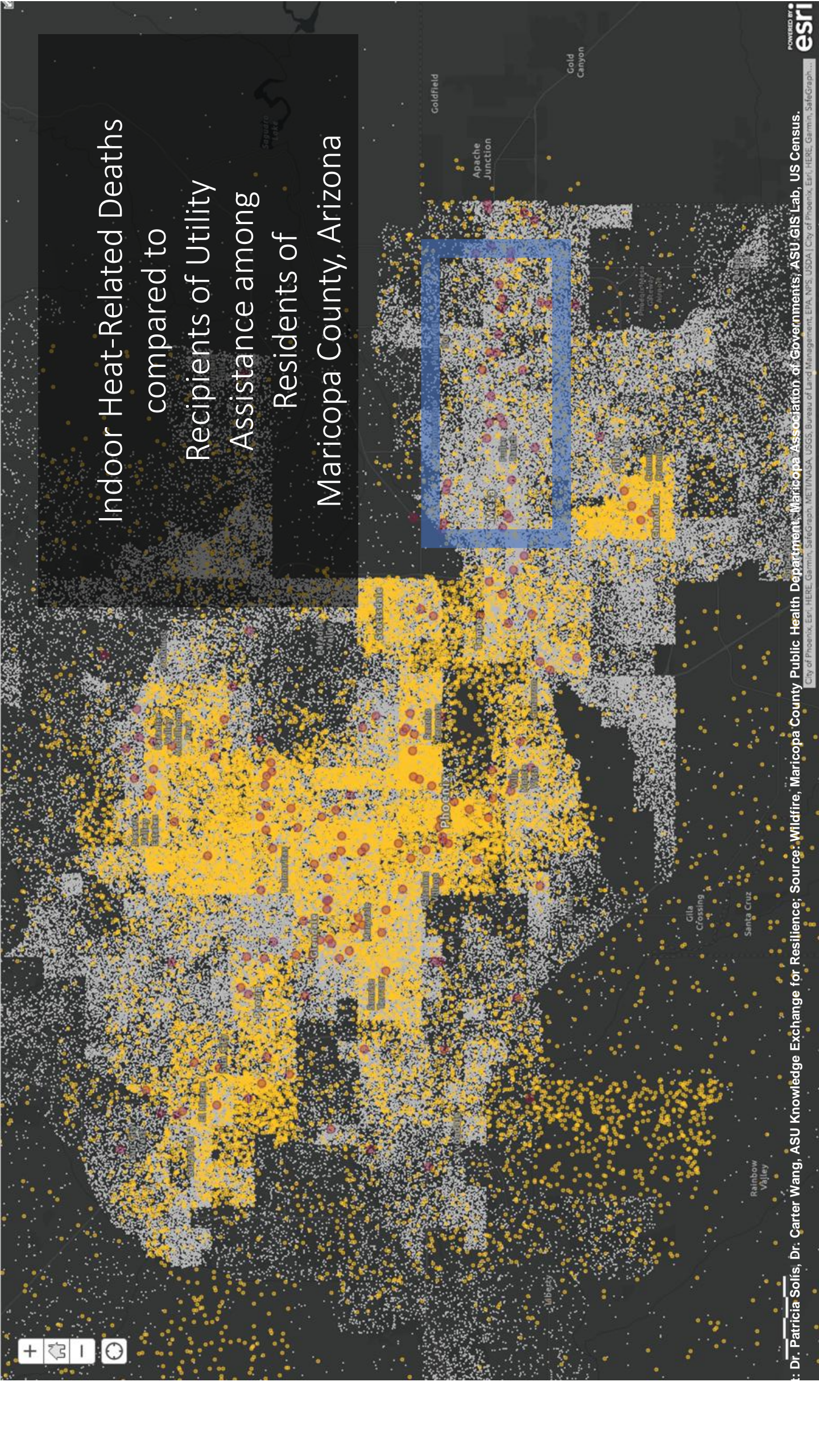


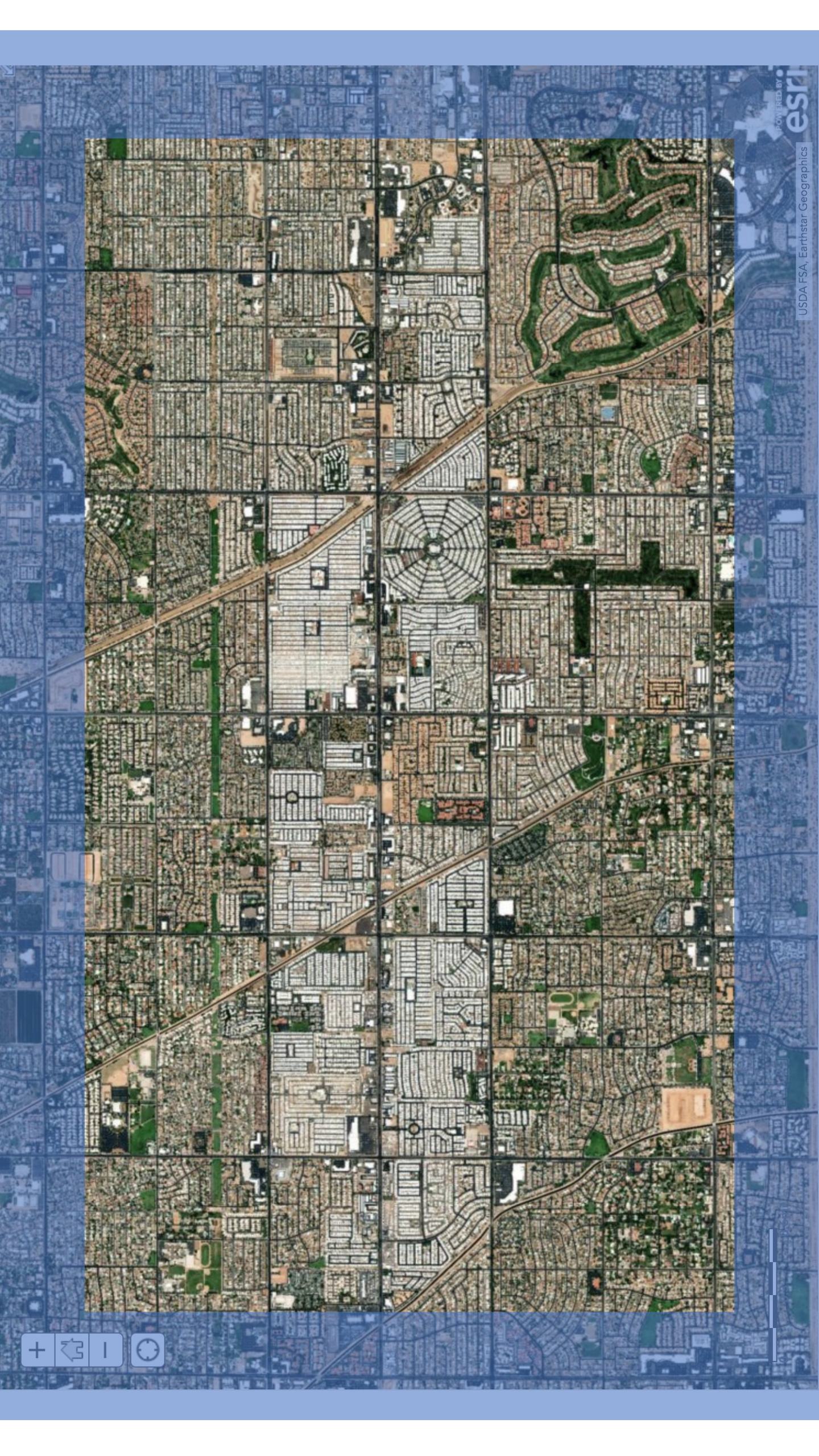
Recipients of Utility Assistance among Residents of Maricopa County, Arizona



Dr. Patricia Solis, Dr. Carter Wang, ASU Knowledge Exchange for Resilience; Source: Wildfire, Maricopa County Public Health Department; Maricopa Association of Governments; ASU GIS Lab, US Census.

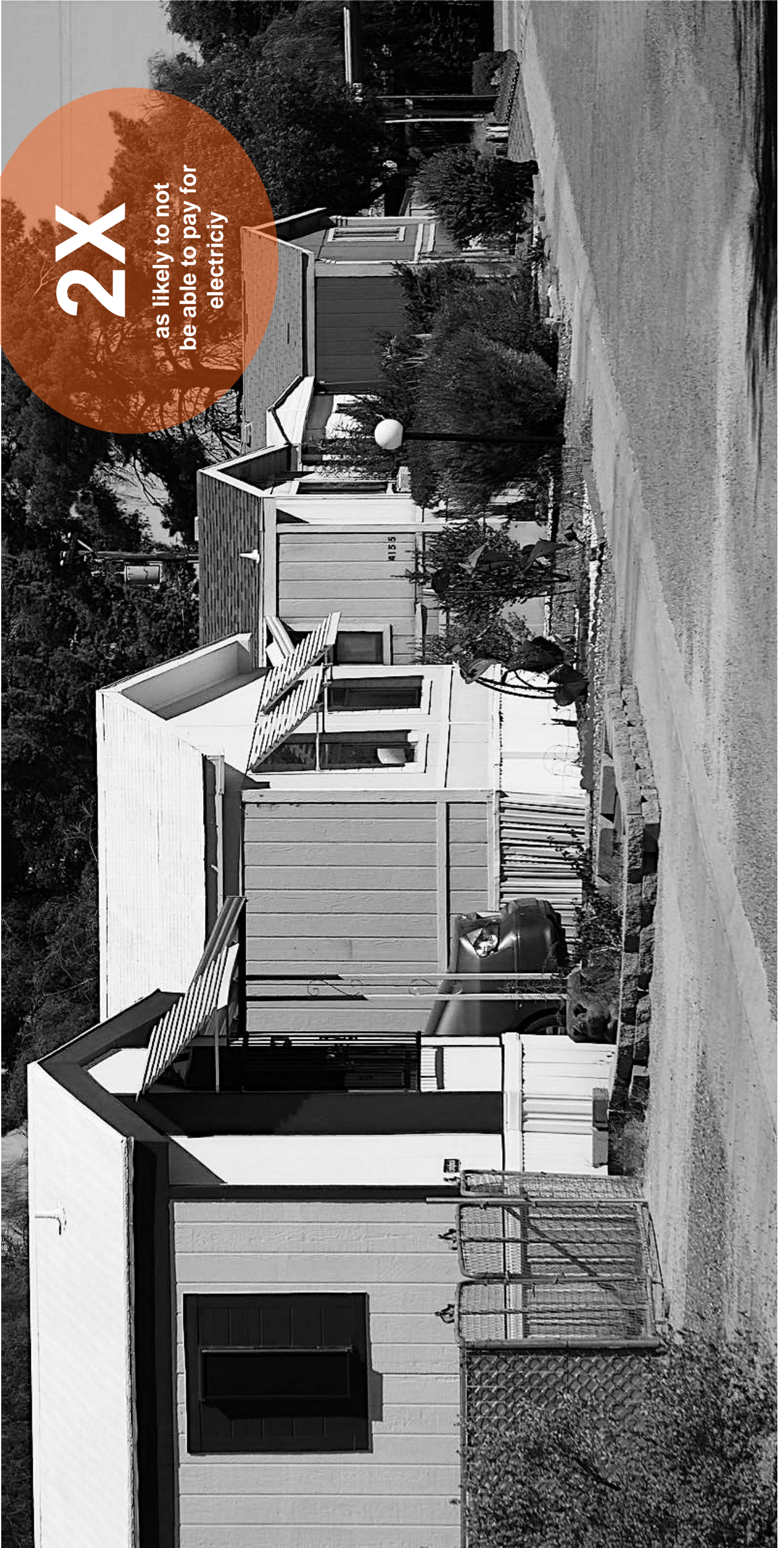
Indoor Heat-Related Deaths compared to Recipients of Utility Assistance among Residents of Maricopa County, Arizona





2X

as likely to not
be able to pay for
electricity



Mobile home residents who perished were **twice** as likely to not have AC present, and those who did, were **three** times more likely to not have electricity turned on due to utility costs



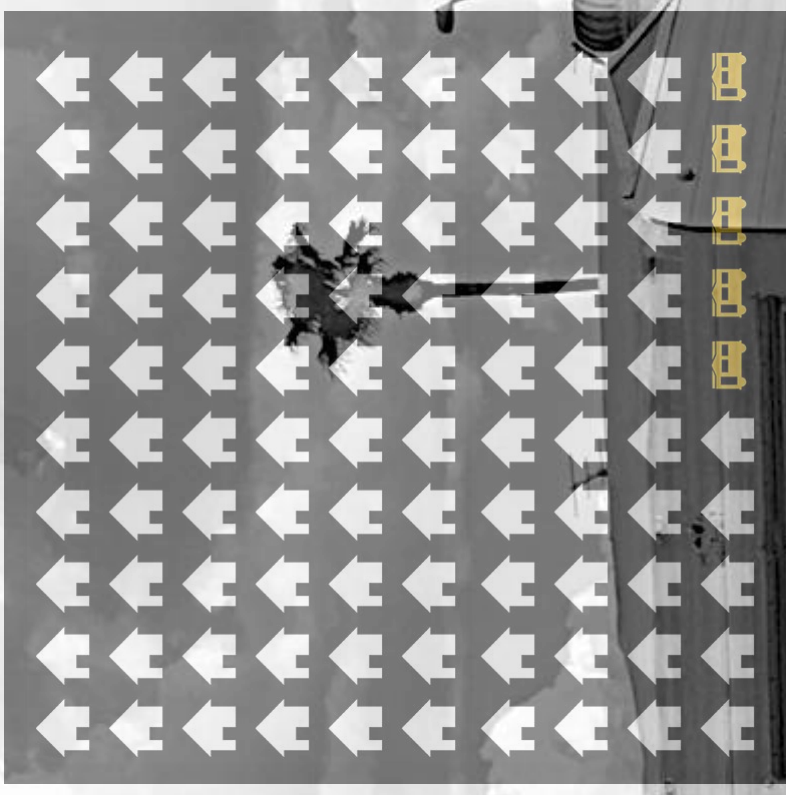
Most women died indoors



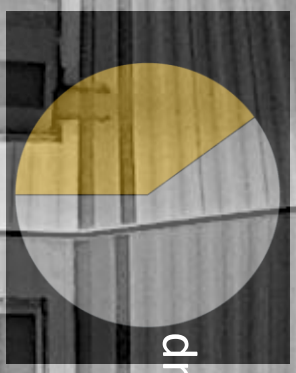
Most men died outdoors



7 in 10 were at least 50 years old



Despite that 5% of housing is mobile homes, trailer residents make up **40%** of indoor deaths



Mobile Homes Concentrated in South & Southwest

Share of Mobile Home Households by Metro, Sized for Number of Mobile Home Households

20 M
US residents
in mobile
home



The Washington Post

Democracy Dies in Darkness

2023 2053

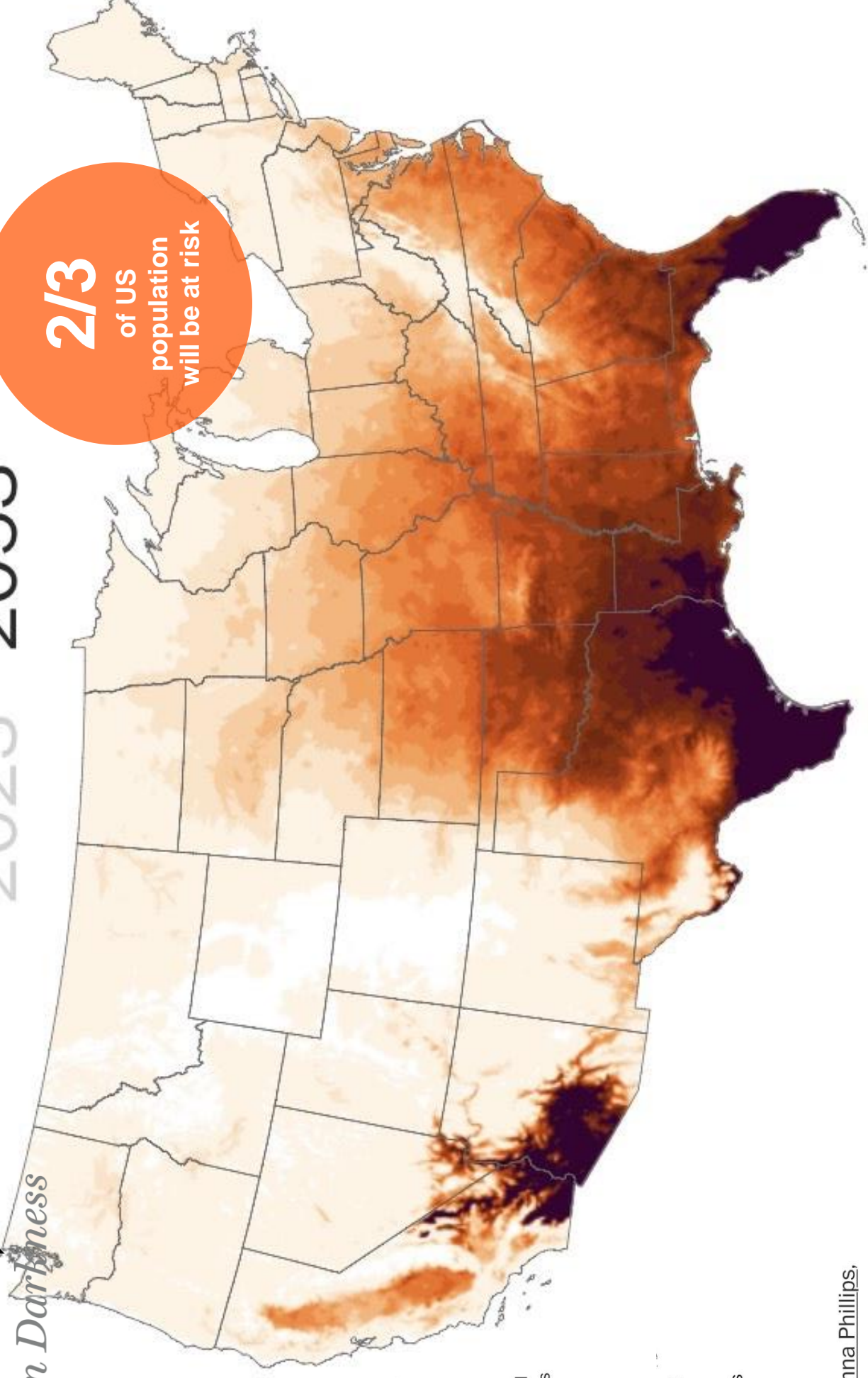
2/3
of US
population
will be at risk

**More dangerous heat waves
are on the way: See the
impact by Zip code.**

By mid-century, nearly two-thirds of Americans will experience perilous heat waves, with some regions in the South expected to endure more than 70 consecutive days over 100 degrees

Days with dangerous heat

Heat index $\geq 100^{\circ}\text{F}$
0 35 70 > 90 days



By [John Muyskens](#), [Andrew Ba Tran](#), [Anna Phillips](#),
[Simon Ducroquet](#) and [Naema Ahmed](#)

Short term

The City of Mesa Fire Department pivoted their summer outreach on heat, **distributing flyers and water** in 12 mobile home parks, reaching around 3,000 units and 8,528

City of Tempe assessed data to **identify residents in distress**

SRP and APS offered joint **workshops** for mobile home residents

8,528
mobile home
residents

82

partner
organizations

Mid term

42 ASU students worked with 12 mobile home park managers to **design technical and policy solutions** with the potential of impacting more than 5,000 residents

Maricopa County Public Health Department **conducted health surveys** of residents in a Phoenix trailer park

SRP studied electricity use and **filled eligibility gaps** in utility assistance programming to reach to customers in manufactured and mobile home housing

42

research
students

Long term

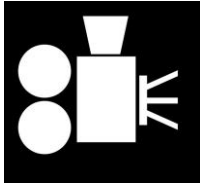
ASU **compiled discoveries** in a Mitigation Guide for Heat Resilience of Mobile Homes

\$3.6B

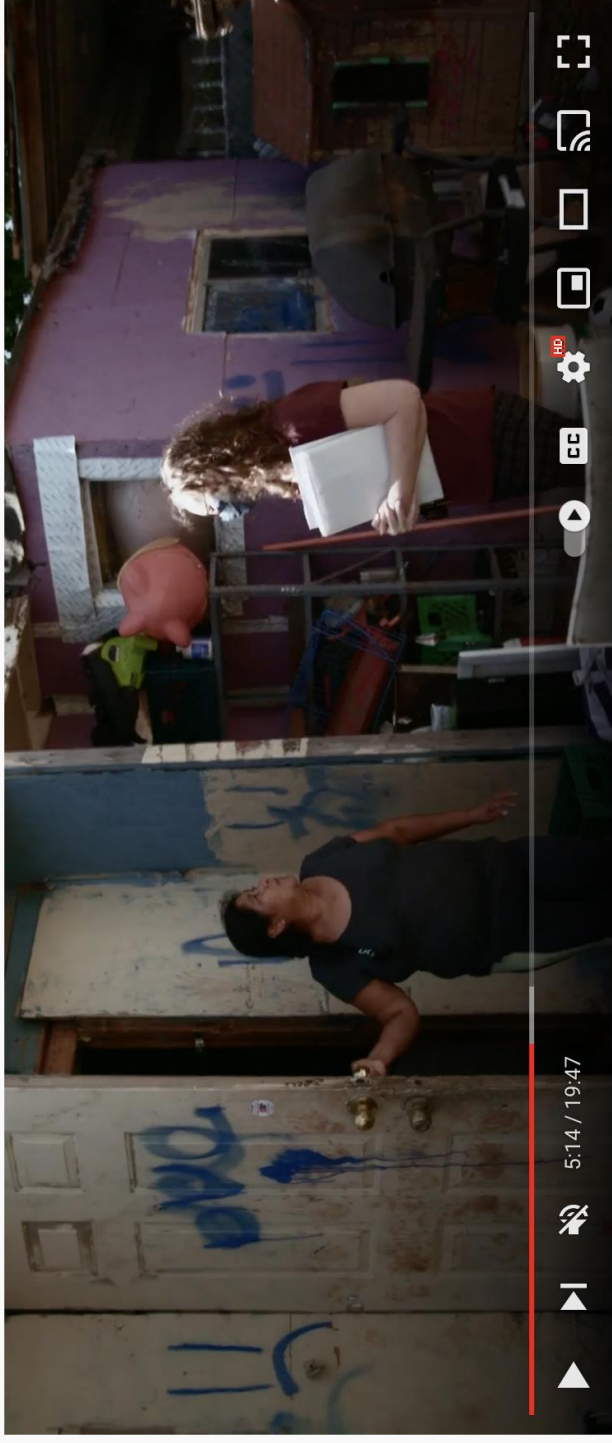
USD

Federal IHEAP budget
mobilized partnerships in housing, services, health, insurance, and government sectors to design pilot programming

A group of **24 stakeholder organizations** united to address the heat vulnerability of the over 72,000 households living in mobile homes in Maricopa County



Search



Origins | A new model for building community resilience

63 views • Dec 16, 2021

0 DISLIKE SHARE DOWNLOAD SAVE ...

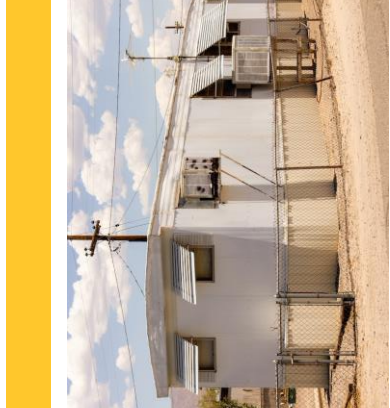


Democracy Dies in Darkness

Climate and Environment

Extreme heat is killing people in Arizona's mobile homes

Residents of older, substandard mobile homes are at higher risk of death in summer's blazing temperatures



By Karen Peterson
July 2, 2021 at 8:23 a.m. EDT

TUCSON — For the past 23 years, Jim Filipiak, 73, has lived in a 1976 single-wide mobile home. Mobile homes dominate the flat landscape of his Tucson neighborhood, a mostly treeless plot near the railroad tracks and Interstate 10. The retiree and Vietnam veteran has remodeled his home and kept up with maintenance, but there's little he can do to shield himself from what has become the norm in Arizona: searing, deadly summer heat.

Filipiak has two window air-conditioners, but they suck up electricity and drive up the bill, so he only runs the AC for the few hottest hours of the day to protect his two rescue dogs. Even if he could afford a more efficient central AC unit, the wiring in his home couldn't sustain it. Instead, Filipiak relies on an evaporative cooler, until summer rains and humidity in July and August render it useless. Then he relies on fans. In mid-June, when Tucson and Phoenix both broke records for triple-digit heat, the interior temperature of his home never dropped below 90 degrees, day or night.

Last summer's relentless, 100-degree heat and compounding drought killed a record 250 people in Arizona — twice the total deaths reported nationally from hurricanes, wildfires, tsunamis, severe storms and floods, and a significant increase from the past decade, when heat-related deaths in Arizona never went above 283. With this summer already dangerously hot, researchers are sounding the alarm about a heat-vulnerable community that has been historically disregarded because of where they live: substandard, aged mobile homes.

Heat death investigations from 2020 are still pending, but at least 13 people in Maricopa County alone died in their mobile homes, said Patricia Solis, a geographer and executive director of the Knowledge Exchange for Resilience at Arizona State University. (Mobile home-specific death totals are not available statewide.) Thousands more are vulnerable again this summer, as punishing temperatures are already smothering parts of the country.

Already the first victims of natural disasters, residents of these older mobile homes are a microcosm of the at-risk population for heat emergencies: the poor and those living on fixed incomes, the very young and the elderly, people with disabilities, people who live alone and people of color. Filipiak's neighborhood includes a Native American community.

"We are beginning to see this to be a real health concern, certainly a moral one," said Margaret Wilder, with the School of Latin American Studies and the School of Geography, Development & the Environment at the University of Arizona. "It should be of concern to any policymaker."

Wilder and Solis are members of the team of researchers, already well-versed in heat- and climate-related studies, who are collaborating on a project led by Munk Kaur, assistant professor in the School of Geography, Development & the Environment at the University of Arizona. It began in 2019; their report will be published this fall.

"We are all exposed to global warming; the temperatures outside are up for all of us, but not all of us are equally vulnerable," Kaur said.

As Phoenix Heats Up, the Night Comes Alive

That will be true for many more cities as the world gets hotter.

Photographs by George Etheredge | Written by Marguerite Holloway



Evening can mean the start of a new day for some residents. "I switch everything around. I do everything at night," said Tee McKee, as she folded clothes in the community laundry room at the Shady Grove Mobile Home and RV Park in Mesa. "I try to put in insulation and old curtains to keep the cool in and the heat out." But, she said, metal RVs roast in the sun and radiate heat long into the night.

Last year, heat caused or contributed to the deaths of 182 people in Maricopa County, which includes Phoenix. Preliminary figures suggest the toll this year will be similar if not higher, according to the health department. Thirty-six percent of those who died in 2018 were 65 or older and at least 23 percent were homeless. Recent research found that mobile home residents are also especially vulnerable. In 2012 and 2014, nearly half the indoor heat deaths occurred in mobile homes, said Patricia Solis, a geographer at Arizona State University.

Dr. Solis is one of dozens of heat experts in the region — part of what Mack Hartman, Phoenix's chief sustainability officer, described as "the epicenter of research related to heat." They are trying to determine, among many things, how best to mitigate heat through urban planning and how to help vulnerable populations, including people who cannot afford air-conditioning. Ultimately, Phoenix could become a model for what it means to be "heat ready."

Some of the research takes place after sunset, as on a July night when Ariane Middel, a professor of urban climate at Arizona State University, and two colleagues pulled Marty, an assemblage of meteorological sensors, through downtown Tempe to examine the microclimate.



Other cities with temperate climates may start to experience heat like Phoenix's in the coming decades, said Dr. Middel. "We are almost a living laboratory. We can test strategies and see different ways to keep adapting and mitigating."

"By the time it gets hot in other places," she said, "they can take what we have learned here."



SCIENCE | CORONAVIRUS COVERAGE

As summer arrives, how will most vulnerable escape deadly heat and COVID-19?

A dangerous and uncharted trifecta of the pandemic, high unemployment, and extreme heat is looming, and cities make plans.

BY STEPHEN LEAHY



PUBLISHED JUNE 16, 2020

Imagine your mother is 86 and of COVID-19. She says it's. Would you advise her to live in an air-conditioned public building?

The United States is facing unemployment, and summer average in much of the country, says Patricia Solis, an Exchange for Resilience at Arizona State University focused on building communities.

"We haven't figured out how to

Even though heat is the season the U.S., the Federal Emergency Management Agency is funding for heat emergencies. Their own, Solis adds.

A fountain provides relief from the summer heat in Queens, New York City, in July 2019. New York—and the rest of the United States—faces an unusually hot summer, and city officials are honing plans for how to relieve those most vulnerable to the heat in the face of COVID-19. PHOTOGRAPH BY GABRIELLA ANGOITTI-JONES. THE NEW YORK TIMES/REXUS

Cost of Living vs SSA Benefits

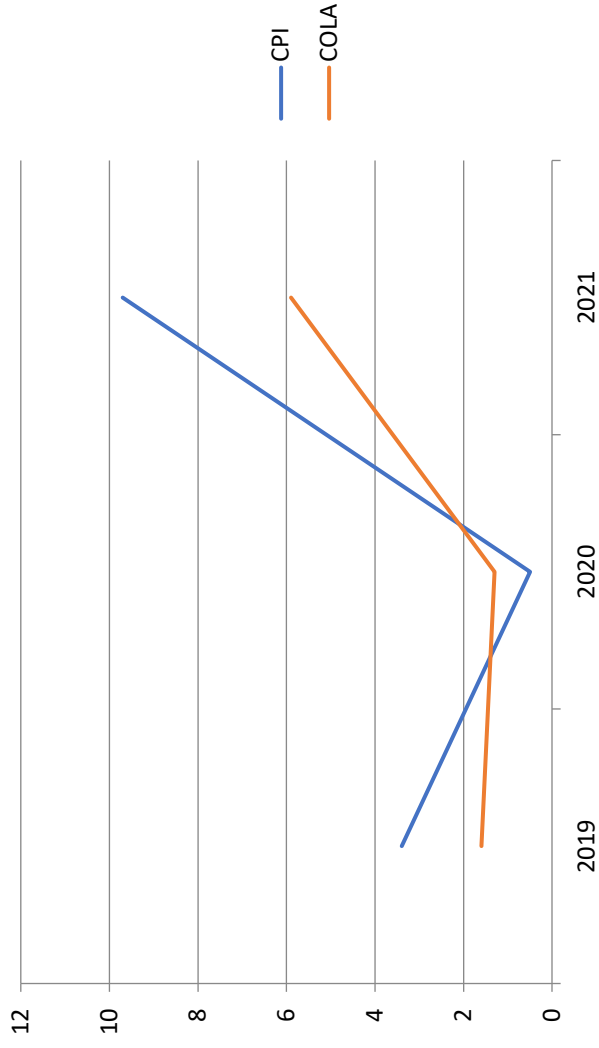


Figure 1: Annual percent change in the Consumer Price Index for the Phoenix-Mesa-Scottsdale MSA relative to annual percent change in Social Security cost-of-living adjustments

Sources: <https://www.ssa.gov/oact/cola/colaseries.html>;
https://www.bls.gov/regions/west/news-release/consumerpriceindex_phoenix.htm

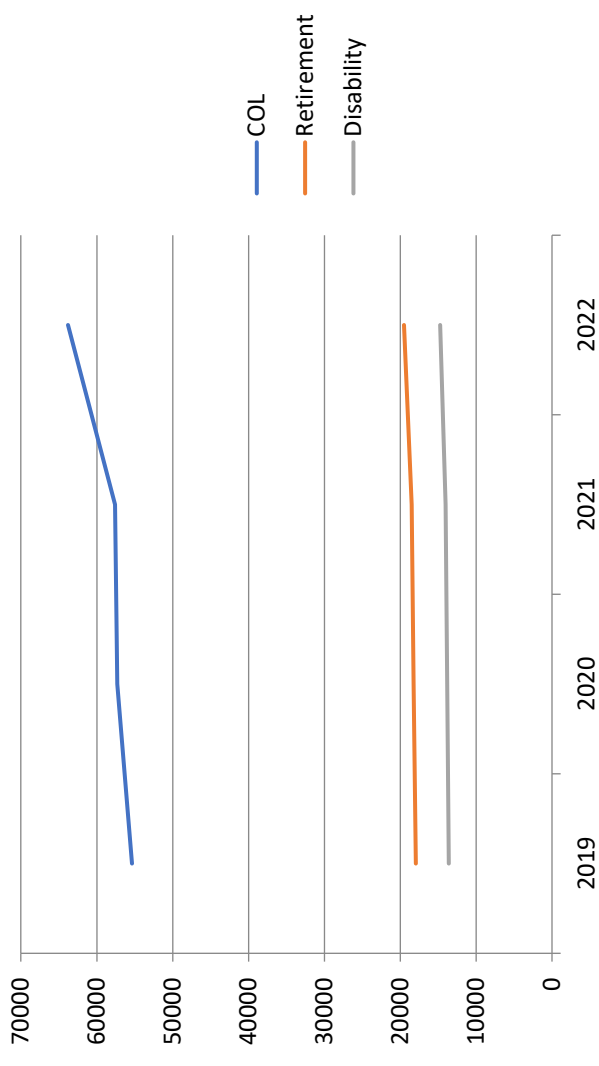


Figure 2: Average annual cost of living in Phoenix relative to national average annual income from Social Security retirement benefits and Social Security disability benefits

Notes: Author's calculations*

*If this graphic is used, someone should double-check my calculations because they were done hastily

Mobile home Parks vs Heat Death by Gender

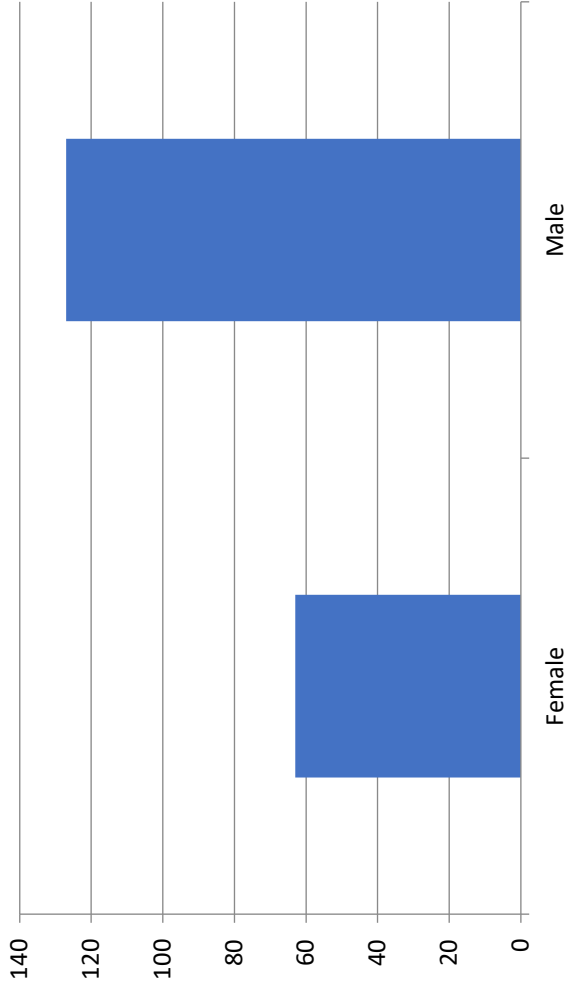


Figure 1: Count of Indoor Heat-Related Deaths in Mobile Homes by Gender in Maricopa County, 2006-2021

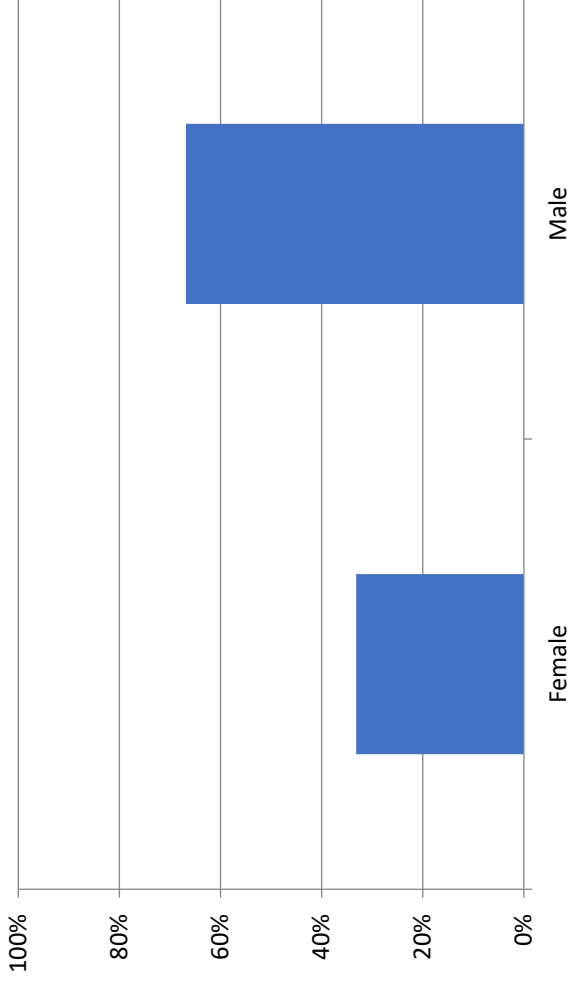


Figure 2: Percent of Indoor Heat-Related Deaths in Mobile Homes by Gender in Maricopa County, 2006-2020

Source: Maricopa County Public Health Department

Mobile home Parks vs Heat Death by Age

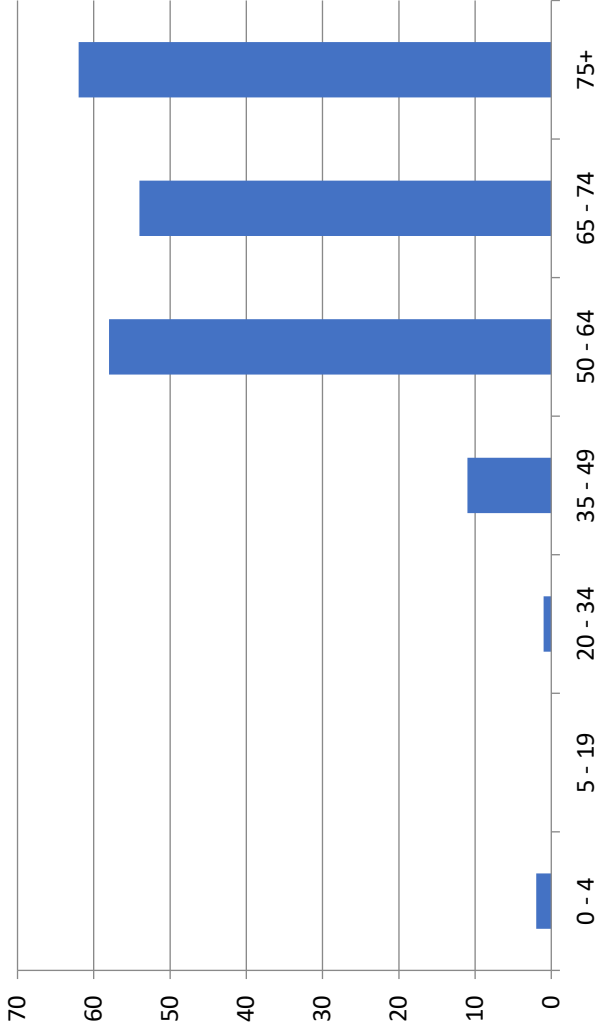


Figure 1: Count of Indoor Heat-Related Deaths in Mobile Homes by Age Group in Maricopa County, 2006-2021

Source: Maricopa County Public Health Department

Notes: One indoor heat-related death in a mobile home is missing due to a lack of data on age. Two indoor heat-related deaths in mobile homes from 2021 are missing due to data suppression and represent deaths that occurred in individuals 49 or younger.

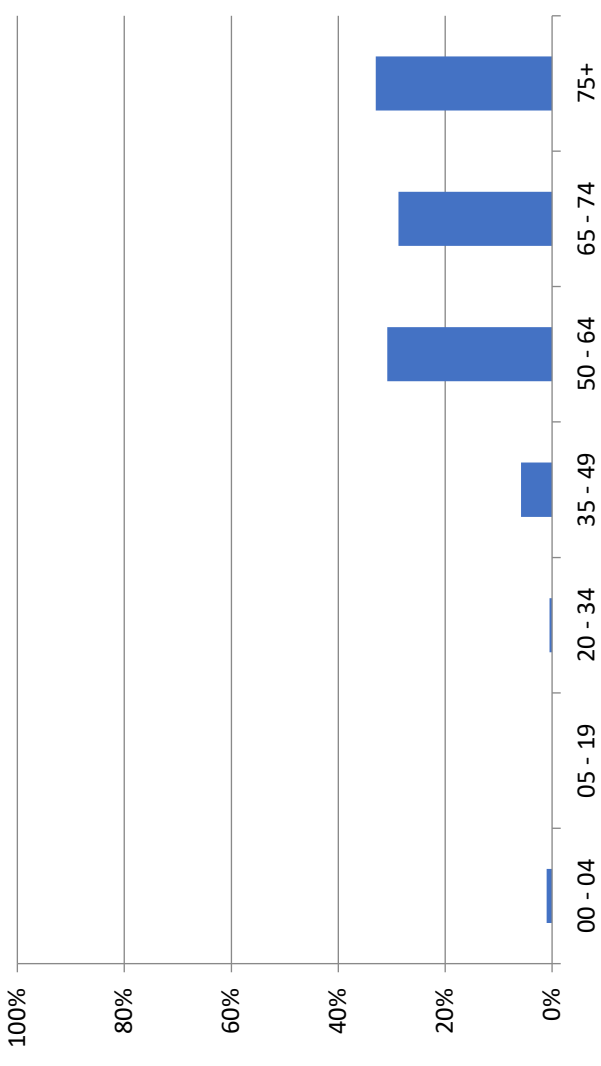


Figure 2: Percent of Indoor Heat-Related Deaths in Mobile Homes by Age Group in Maricopa County, 2006-2020

- Differences in the average neighborhood conditions for mobile home households and single-family households in the Phoenix Metropolitan Area, 2017.

Neighborhood condition	Mobile home households	Single-family households	Average in Maricopa County
Median household income, \$	46 544	71 369	65 252
Percentage of population below poverty level, %	19.7	12.5	12.2
Median housing Value, \$	33 565	261 793	276 800
Median Rent, \$	1026	1288	1119
Median age	44.0	40.0	36.6
Percentage of population 65 and over	26.7	17.6	15.1

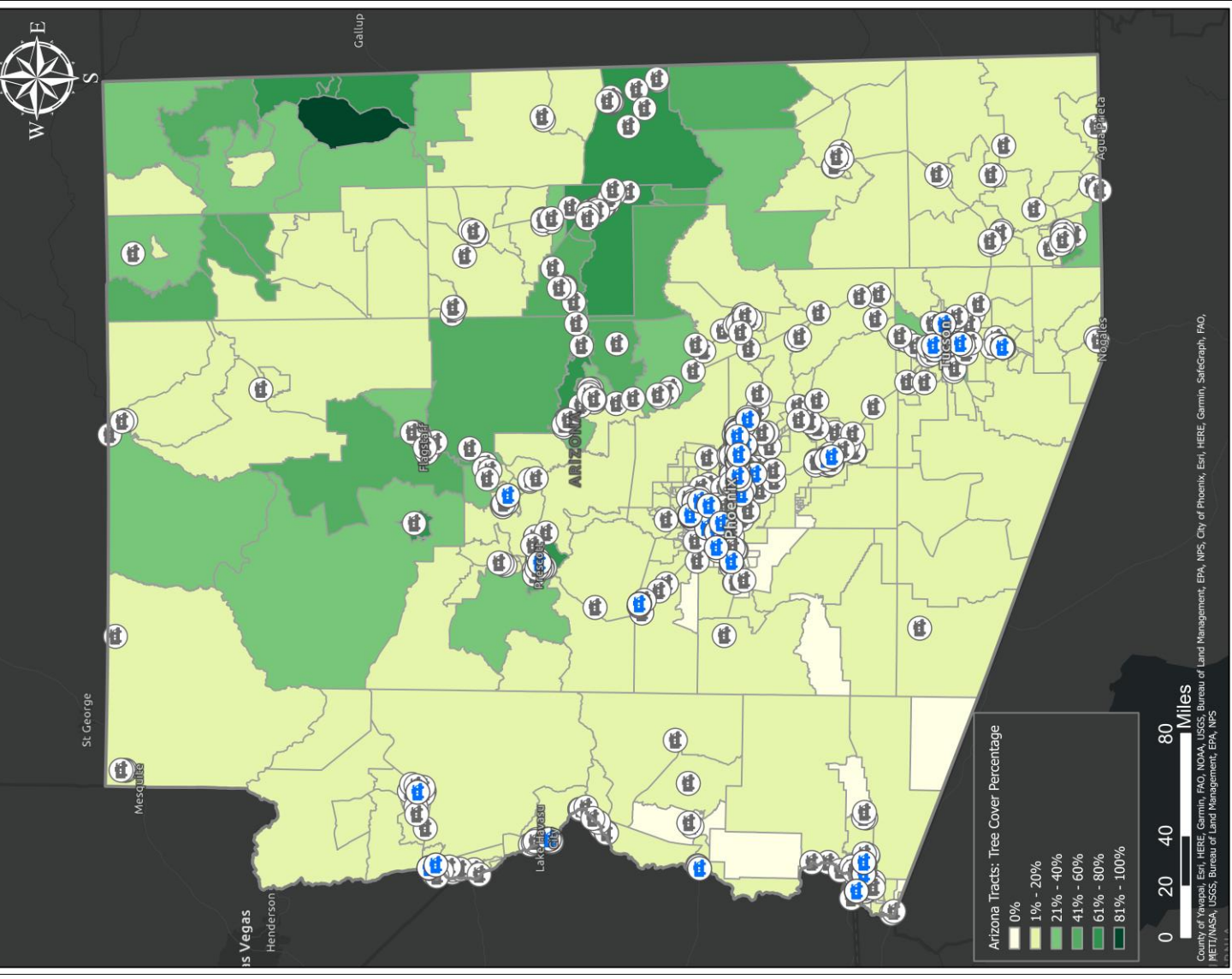
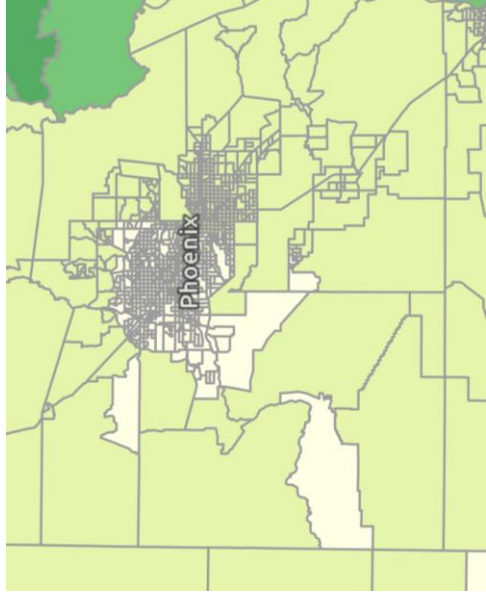
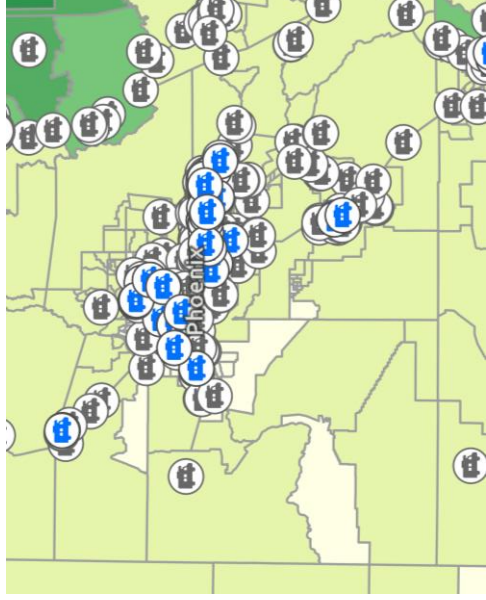
Source: Knowledge Exchange for Resilience, ASU, 2019.

- Average differences in heat exposure and its economic costs for survey participants living in mobile homes in Mesa and single-family homes in South Phoenix.

Variable	Mobile home respondents, %	Single-family home respondents, %
Heat exposure		
Experience health impacts from typical summer temperature	70	60
Experience a negative impact from heat	52.4	41.2
Uncomfortably warm inside their homes often or very often	60	41.2
Experience heat-related symptoms inside their homes	75	55.6
Leave their home by their choice due to the high temperature inside	66.7	42.9
Have no choice but to leave due to the high temperature inside	47.1	29.4
Have to change their normal behavior	71.4	58.8
Use a central air conditioner	47.6	94.1
Use a window air conditioner	61.9	5.9
Economic costs		
Spend more than 10% from monthly income on the electricity during the summer	39	13
The electricity bill has become more expensive over the last 5 years	72.2	38.5

Mobile Home Parks vs Tree Cover

- Most mobile home parks in Maricopa County are in areas containing 0-20% tree cover.





Thermal Drone Images

Heat Solutions in Development



The images display our third-party collaboration with 3M and Sky Cool, installing a Reflective Heat Film to minimize roof heat absorption.

This product aims to relieve the high-temperature retention of mobile home roofs. We will continue to monitor the product's performance and its proposed benefits.

AN ANALYSIS OF STATE LEGISLATION AFFECTING MOBILE HOME RESIDENTS

ARIZONA STATE UNIVERSITY

Introduction

Based on research provided by the *Knowledge Exchange for Resilience* (KER), which found that people who live in mobile homes are 6 to 8 times more likely to die of heat-associated deaths than those living in non-manufactured housing, we were motivated to look for legislative solutions that could help reduce the number of heat-related injuries and deaths associated with mobile homes. We began to investigate the causes behind this staggering statistic and discovered that there were a number of interrelated issues, including but not limited to the heat-related harms, which put residents of mobile home parks in a powerless position under the law.

A connection was made with the *Arizona Association of Manufactured Home Owners* (AAMHO) which led to an ongoing relationship discussing and categorizing the concerns of residents. Based on an extensive number of resident complaints cataloged by AAMHO, we began to develop legislative solutions to the most pressing issues presented.

We found that two broad areas of concern were predominant:

1. Heat-related dangers clearly required intervention in order to prevent further harm to residents; and
2. Other resident protections, including eviction and landlord retaliation, were also of major concern.

Based on these findings, we decided to perform a comparative analysis of state-level legislation pertaining to mobile home residents to determine where Arizona stood on a national scale.

Comparative Analysis of State Legislation

The first step in our legislative analysis was to conduct an in-depth 50-state comparative evaluation of state-level mobile home legislation (see **Appendix A** below). This deep dive into state legislation was performed with two major areas of analysis in mind, based on the concerns of KER and AAMHO.

The first, heat-related protections, included identifying any state protections from natural conditions, as well as any other legislation which could be analogous to heat-related protections for residents. We found that no states have direct protections for heat-related dangers to residents of mobile home parks. Many states within the United States (US) provide protection from certain natural conditions, but these protections are often limited to simply requiring a landlord to provide electrical power or running water, or prevent the accumulation of stagnant water. However, a small number of states provide protections from more specific weather-related conditions (see Connecticut, Nevada, Oregon, Rhode Island, or Washington in **Appendix A** below).

In one of the best examples of legislation protecting residents from natural conditions, Minnesota law requires that any mobile home park with more than ten mobile homes “shall provide a safe place of shelter for park residents or a plan for the evacuation of park residents to a safe place of shelter within a reasonable distance of the park for use by park residents in times of severe weather, including tornadoes and high winds” (see Minnesota Statutes § 327.20 or Minnesota in **Appendix A** below).

Based on these findings, we began to develop policy recommendations in order to help prevent heat-related harms to mobile home residents. Concurrently, we also began to develop policy proposals relating to other mobile home resident concerns, the second area analyzed in this study. These concerns included eviction without cause, specifically the timeline for eviction proceedings, as well as protections from landlord retaliation. Once these findings were complete, we now had a basic set of legal standards to which we could compare Arizona law.

Arizona Mobile Home Parks Residential Landlord and Tenant Act

Following the broad analysis of all state legislation, we began to specifically investigate Arizona state legislation which affected the residents of mobile home parks. This legislation, the *Arizona Mobile Home Parks Residential Landlord and Tenant Act* (MHRPLTA), is codified in Title 33, Chapter 11 of the Arizona Revised Statutes (A.R.S.). We concentrated a majority of our efforts on Articles 2, 3, and 4 of the MHRPLTA, which address landlord obligations, tenant obligations, and remedies, respectively.

We identified shortcomings in Arizona law in comparison to other state legislation and began to develop state-specific policy recommendations based on these shortcomings (see **Appendix B** below). These policy recommendations were also divided into two groups, with the first relating to heat-related protections for mobile home residents, and the second concerning other resident protections, mainly evictions.

Legislative Proposals for Heat-Related Protections

The first set of policy recommendations developed were based around protections from heat-related harms for mobile home residents. Based on the information provided by KER, we constructed legislative language that could either replace or be added to existing Arizona law. The first suggested change was an addition to A.R.S. 33-1434(A), which regulates a landlord's response to utility interruptions in a mobile home park. The current law, providing minimal protection for residents, allows for dangerous conditions to occur within the park in the event of a loss of power. As a result, residents using continuous positive airway pressure (CPAP) machines or other electrical devices that assist with breathing or other health-related issues may be placed in significant danger in the event of an electrical outage in a mobile home park. Based on these findings, we proposed adding a section requiring mobile home park landlords to remedy any interruption of electrical service to tenants within four hours and, if they are not successful in doing so, provide tenants with commercial-generated electrical power until power is restored (see A.R.S. 33-1434(A) in **Appendix B** below).

The next proposal, also an addition to existing law, was to A.R.S. 33-1452(F). This proposed change would prohibit mobile home park landlords from preventing residents from using alternative cooling methods. With the significant number of heat-related deaths in mobile home parks, we felt that any restriction on residents using things such as air-conditioning (AC) units or window coverings in order to cool their home was unduly prohibitive (see A.R.S. 33-1452(F) in **Appendix B** below).

The final policy suggestion we had came in the form of an entirely new section to be added to the MHRPLTA. This added legislation would require park landlords to provide to all tenants a plan for the sheltering and/or the safe evacuation to a safe place of cooling shelter of the tenants of the park in times of severe heat. The shelter or evacuation plan shall be developed with the assistance and approval of the municipality where the park is located and the landlord shall provide each resident with a copy of the approved cooling shelter or evacuation plan (see **Appendix B** below). In order to support this additional legislation, we felt it was also necessary to make an addition to A.R.S. 33-1474, concerning essential services. We proposed an additional section to the law which would require mobile home park landlords to provide tenants with a list of cooling stations or shelters to be used in case of an emergency (see A.R.S. 33-1474 in **Appendix B** below).

Legislative Proposals for Eviction and Other Protections

In addition to the heat-related policy suggestions, we also developed a number of minor changes to other parts of the MHRPLTA, based on resident concerns documented by AAMHO. Of particular concern is the length of time given to residents after the termination of a lease agreement (or eviction). In Arizona, residents who have breached their lease agreement often have thirty days to vacate the property. This does not provide the resident with enough time to either remedy the issue, present their case before an administrative law judge, or ready their home for transport. Based on this, we have proposed changes to A.R.S. 33-1476(D)(1), (4), and (5). These changes would allow the resident sixty days, replacing the previous period of thirty days, after notice of a breach before the termination of the lease agreement (see A.R.S. 33-1476(D)(1), (4), and (5) in **Appendix B** below).

Another law requiring an update in the time period provided to a mobile home park resident involves A.R.S. 33-1476(H). This proposal would replace the one hundred eighty

day notice of a change in use of a mobile home park with a three hundred and sixty five day notice before the actual termination of the rental agreement. Change in use occurs, for example, when a mobile home park is changed from a 55+ park to a family park, which could result in the involuntary removal of certain residents. The legislative change would allow these residents a year, rather than six months, to prepare themselves for removal from the park (see A.R.S. 33-1476(H) and A.R.S. 33-1476.01(A) in **Appendix B** below).

The last set of proposed legislative changes involve the updating of monetary contributions to and collections from the Mobile Home Relocation Fund (MHRF). A.R.S. 33-1476.01(C)(1) and (3) regulate the distribution of funds from the MHRF under different circumstances and require updating in regards to the amounts distributed. A.R.S. 33-1476.01(D), (E)(1) and (2), and (G) regulate the amounts paid by a mobile home park landlord under different circumstances and also require updating in regards to the amounts paid. The final change we have suggested to the MHRPLTA is to A.R.S. 33-1476.03(A), which requires park residents to pay a state assessment based on the taxable assessed valuation of their mobile home. The rate of the taxable assessed value of the home needs to be updated to reflect current conditions (see A.R.S. 33-1476.03(A) in **Appendix B** below).

Appendix A: 50-State Comparative Analysis of State Mobile Home Legislation

State	Mobile Home Legislation	Protection from Natural Conditions	Protection from Eviction Without Cause	Protection from Landlord Retaliation
Alabama	Ala. Stat. § 24-5-1 et seq deals with mobile homes but only covers licensing and records requirements	General requirement that landlords "supply running water and reasonable amounts of hot water at all times and reasonable heat" but only where law explicitly requires it for that building (§ 35-9A-204)	No	General provision prohibiting landlords from retaliating against any tenant (not specific to mobile homes) (§ 35-9A-501)
Alaska	Relevant provisions found within Alaska's Uniform Residential Landlord and Tenant Act Ak. Stat. § 34.03.225	Yes - provides tenant with remedy (deduct costs of obtaining from rent, recover damages, or find reasonable substitute housing) if the landlord fails to supply heat, water, hot water or essential services; not specific to mobile homes (§ 34.03.180)	Yes (§ 34.03.225)	General provision prohibiting landlords from retaliating against any tenant (not specific to mobile homes) (§ 34.03.310)

Arizona	Mobile Home Parks Residential Landlord & Tenant Act Ariz. Rev. Stat. § 33-1401 et seq.	General requirement that landlord "supply running water and reasonable amounts of hot water at all times, reasonable heat and reasonable air-conditioning or cooling where such units are installed and offered, when required by seasonal weather conditions" except where not required by law for that building (§ 33-1324)	Yes (§ 33-1476)	Yes (§ 33-1491)
Arkansas	No	No	No	No
California	Mobilehome Residency Law Cal. Civil Code § 798 et seq	No special protections; Health and Safety Code does require emergency preparedness plans (§ 18603) and Civil Code § 1103 requires disclosure of natural hazards upon transfer	Yes (§§ 798.55, 798.56)	Yes - affirmative protection for association, rent increases, etc.; prohibition on arbitrary enforcement of park rules
Colorado	Mobile Home Park Act Colo. Stat. § 38-12-200 et seq	Requires that landlords supply water and wrap pipes in heated pipe tape (§ 38-12-212)	Yes (§ 38-12-203 & 205)	Yes - broad prohibition on retaliatory conduct (§ 38-12-214)

<p>Connecticut</p>	<p>Mobile Manufactured Homes and Mobile Manufactured Home Parks Conn. Gen. Stat. § 21-64 et seq</p>	<p>Requires owner to maintain the premises and regrade land when necessary to avoid accumulation of stagnant water and prevent detrimental effects of moving water; also requires maintenance of rental units to withstand adverse effects of weather conditions (§ 21-82)</p>	<p>Yes (§ 21-80(b)(1))</p>	<p>Yes (§ 21-80a)</p>
<p>Delaware</p>	<p>Manufactured Homes & Manufactured Home Communities Act Del. Stat. § 7001 et seq.</p>	<p>Tenant or group may petition court for receivership if: landlord had a duty to provide heat, running water, electricity, or sewage; they notified landlord; and landlord failed to provide for 5 days; or if there are conditions imminently dangerous to life (§ 7061); landlord also must regrade lot area when necessary to prevent accumulation of standing water and detrimental effects of moving water (except in flood plains) (§ 7008(a)(13))</p>	<p>Yes (§ 7016)</p>	<p>Yes (§§ 7018(b); 7019)</p>

<p>Florida</p>	<p>Mobile Home Park Lot Tenancies Fla. Stat. § 723.001 et seq.</p>	<p>Not really - does state that if a mobile home is damaged or destroyed due to "wind, water, or other natural force" it can be rebuilt on the same site (§ 723.041(5)); general provision requiring heat and running water does not apply to mobile homes (§ 83.51)</p>	<p>Yes (§ 723.061)</p>	<p>Yes (§ 723.0615)</p>
<p>Georgia</p>	<p>Only has act dealing with abandoned mobile homes Ga. Stat. § 44-7-116</p>	<p>Landlord must notify tenant of any prior damage from flooding or will be liable for damage from flooding (§ 44-7-20)</p>	<p>General provision for residential tenant (§ 44-7-24(d)(2))</p>	<p>General provision for residential tenant specifying prima facie case of retaliation (§ 44-7-24)</p>
<p>Hawaii</p>	<p>No</p>	<p>General provision allowing tenants to quit the premises and terminate lease for fire or other casualty damage not caused by tenant/landlord (Hi. Rev. Stat. § 521-65)</p>	<p>General provision allowing eviction for listed reasons (Hi. Rev. Stat. § 521-74(b))</p>	<p>General provision prohibiting retaliatory evictions and rent increases (Hi. Rev. Stat. § 521-74(a))</p>
<p>Idaho</p>	<p>Manufactured Home Residency Act Ida. Stat. § 55-2001 et seq.</p>	<p>Not really - Allows resident to bring action for specific performance if landlord fails to provide electrical, water, or sewer services (§ 55-2014)</p>	<p>Yes (§ 55-2010)</p>	<p>Yes (§ 55-2015 and 55-2008)</p>

<p>Illinois</p>	<p>Mobile Home Landlord & Tenant Rights Act Ill. Comp. Stat. ch. 765, act. 745</p>	<p>Tenant can terminate lease without notice if condition renders mobile home uninhabitable or poses an imminent threat to health, welfare, and safety of any occupant (765 ILCS 745/21); repair utility issues resulting from emergencies in reasonable amount of time (765 ILCS 745/11(c))</p>	<p>Yes (765 ILCS 745/15 & 745/16)</p>	<p>Yes (765 ILCS 745/16)</p>
<p>Indiana</p>	<p>Health, Sanitation, and Safety: Mobile homes Ind. Stat. § 16-41-27-1 et seq</p>	<p>General tenant provision requiring the following if provided at the time tenant entered the rental agreement: electrical systems, plumbing systems to supply hot and cold running water, sanitary systems, heating, ventilating, and air conditioning systems (with emphasis on heat)</p>	<p>Yes (§ 16-41-27-30)</p>	<p>No</p>
<p>Iowa</p>	<p>Manufactured Home Communities or Mobile Home Parks Residential Landlord Tenant Law Iowa Stat. § 562B.1 et seq</p>	<p>No</p>	<p>Yes (§§ 562B.32(3), 562B.25, 562B.25A)</p>	<p>Yes (§§ 562B.32; 562B.19)</p>

<p>Kansas</p>	<p>Mobile Home Parks Residential Landlord and Tenant Act Kan. Stat. § 58-35,100 et seq</p>	<p>No</p>	<p>Yes (§§ 58-25,120; 58-25,123)</p>	<p>Yes (§§ 58-25,114; 58-25,135)</p>
<p>Kentucky</p>	<p>Minimal mobile home community permitting requirements in administrative code at 902 Ky. Admin. Regs. Ch. 15; has also adopted Uniform Residential Landlord and Tenant Act at Ky. Rev. Stat. & R. Serv. § 383.500 et seq.</p>	<p>Somewhat - does have two requirements for mobile home communities located in a floodplain: quadruplicate plan and flood insurance (902 Ky. Admin. Regs. 15:010(4)(2)); also has generally applicable statute that provides tenant with remedies for landlord noncompliance that affects health and safety/wrongful failure to provide emergency services (Ky. Rev. Stat. & R. Serv. § 383.635 & 383.640)</p>	<p>No</p>	<p>General provision prohibiting retaliatory evictions and rent increases (Ky. Rev. Stat. & R. Serv. § 383.705)</p>
<p>Louisiana</p>	<p>No specific rental act (there is a Manufactured Home Property Act dealing with building requirements at § 1149 et seq); provisions relating to mobile</p>	<p>Not really - does require the building to comply with requirements set forth in FEMA manual (La. Stat. Ann. § 912.22(8))</p>	<p>No</p>	<p>No</p>

	homes located within sections dealing with lessee rights generally La. Stat. Ann. §§ 3259.1; 3259.3			
Maine	Regulation of Mobile Home Parks; Landlord and Tenant Me. Stat. tit. 10, ch. 953	Somewhat - no specific mention of weather/natural conditions but allows tenant to use breach of warranty of habitability as an affirmative defense to action to terminate rental agreement ((Me. Stat. tit. 10, §§ 9097(11), 9099)	Yes (Me. Stat. tit. 10, § 9097)	Yes (Me. Stat. tit. 10, § 9097(1-A)); also reasonable rules required (Me. Stat. tit. 10, § 9097(4))
Maryland	Md. Code Ann., Real Prop. tit. 8A (Mobile Home Parks)	General provision providing a remedy for tenants/imposing a duty on landlords to correct defects that may result in a "serious and substantial threat to life, health or safety of occupants" including lack of heat, light, electricity, or hot or cold running water (Md. Code Ann., Real Prop. § 8-211(e))	Yes (Md. Code Ann., Real Prop. § 8a-1101)	Yes (Md. Code Ann., Real Prop. § 8a-1301); also requires reasonable rules delivered in writing (Md. Code Ann., Real Prop. § 8a-301(d))

<p>Massachusetts</p>	<p>Located generally within section on licenses; Mass. Gen. Laws An. ch. 140 §§ 32f-32s; also regulations in Mass. Code Regs. 940 10.00 et seq (Manufactured Housing Community Regulations)</p>	<p>No - does provide tort action for tenants that sustain injuries after notifying landlord of unsafe condition (Mass. Gen. Laws Ann. ch. 186 § 19)</p>	<p>Yes (Mass. Gen. Laws Ann. ch. 140 § 32J and 940 Mass. Reg. 10.08)</p>	<p>Yes - with potential substantial damages for landlord (Mass. Gen. Laws Ann. § 32N & 940 Mass. Code Reg. 10.04); also a requirement that rules applied uniformly and rebuttable presumption that rules applied unequally are unfair (Mass. Gen. Laws Ann. ch. 140 § 32L)</p>
<p>Michigan</p>	<p>Revised Judicature Act of 1961 (Mich. Comp. Laws § 600.5771 et seq.) and Mobile Home Commission Act (Mich. Comp. Laws § 125.2301 et seq)</p>	<p>No</p>	<p>Yes (Mich. Comp. Laws § 600.5775)</p>	<p>Yes (Mich. Comp. Laws § 600.5720)</p>
<p>Minnesota</p>	<p>Manufactured Home Park Lot Rentals, Minn. Stat. Ann. § 327C</p>	<p>Yes - requires a plan for sheltering or safe evacuation of mobile home residents in parks with fewer than 10 homes in the event of severe weather conditions (like tornadoes, high winds, and floods); also requires a</p>	<p>Yes (Minn. Stat. Ann. § 327C.09 & 327C.095)</p>	<p>Yes (Minn. Stat. Ann. § 327C.12)</p>

		shelter within reasonable distance for residents of parks with more than 10 homes and that the owner provide each resident with a copy of the shelter/evacuation plan (Minn. Stat. Ann. § 327.20)		
Mississippi	No	No	No	No
Missouri	No - only has building standards for manufactured homes	No	No	No
Montana	Montana Residential Mobile Home Lot Rental Act, Mont. Code § 70-33-101 et seq.	Yes - if the landlord fails to provide running water, electric gas, etc. the tenant can notify the landlord and then procure the essential service needed and deduct it from rent; find substitute housing; or recover damages (Mont. Code § 70-33-406)	Yes (Mont. Code § 70-33-433)	Yes (Mont. Code § 70-33-431)
Nebraska	Mobile Home Landlord & Tenant Act, Neb. Rev. Stat. § 76-1450 et seq.	No specific provision - landlord must supply outlets for utilities and correct any deficit within a reasonable amount of time (Neb. Rev. Stat. §§ 76-1498 & 76-1492) General statute	No - tenant must violate § 76-1493 but landlord has discretion to designate breach	Yes (Neb. Rev. Stat. § 76-14,106); also requires reasonable and uniformly applies rules (Neb. Rev. Stat. § 76-1494)

		providing tenant with remedies if landlord fails to supply heat, water, hot water or other essential services under Uniform Residential Landlord Tenant Act (Neb. Rev. Stat. § 76-1427)		
Nevada	Landlord and Tenant: Manufactured Home Parks, Nev. Rev. Stat. 118B et seq.	Mobile home specific provision stating that mobile home is unfit for occupancy if essential service is not provided and that tenant may procure substitute housing and recover or deduct the cost (Nev. Rev. Stat. § 118B.220); also general provision requiring habitability of dwelling unit including effective waterproofing and weather protection, a water supply, and electrical equipment in good working order (Nev. Rev. Stat. § 118A.290)	Yes (Nev. Rev. Stat. § 118B.200)	Yes (Nev. Rev. Stat. § 118B.210); also requires reasonable, written rules enforced uniformly (Nev. Rev. Stat. § 118B.100)

<p>New Hampshire</p>	<p>Regulation of Manufactured Housing Parks, N.H. Rev. Stat. § 205-a:1 et seq.</p>	<p>Provides mobile home tenants with a cause of action against landlord to enjoin threat stemming from conditions which may endanger or materially impair the health/safety but no specific references to weather (N.H. Rev. Stat. § 205-a:15)</p>	<p>Yes (N.H. Rev. Stat. § 205-a:4)</p>	<p>Yes (N.H. Rev. Stat. § 540:13-a)</p>
<p>New Jersey</p>	<p>Located in two separate sections: N.J. Stat. Ann. § 46:8c-1 et seq. and §§ 2A ch. 18 & ch. 42</p>	<p>General provision authorizing tenant to bring an action when a dwelling lacks heat, running water, electricity, or sewage (N.J. Stat. Ann. § 2A:42-88)</p>	<p>Yes (N.J. Stat. Ann. § 2A:18-61.1)</p>	<p>Yes (N.J. Stat. Ann. § 2A:42-10.10 (made applicable to mobile homes by 2A:42-10.13)</p>
<p>New Mexico</p>	<p>Mobile Home Parks, N.M. Stat. Ann. § 47-10-1 et seq.</p>	<p>General provision requiring that the owner supply running water and a reasonable amount of hot water at all times (except when not required by law) (N.M. Stat. Ann. § 47-8-20)</p>	<p>Yes (N.M. Stat. Ann. § 47-10-5)</p>	<p>Yes (N.M. Stat. Ann. § 47-10-15); also includes written rules requirements</p>
<p>New York</p>	<p>Specific mobile home provisions within Landlord-Tenant law section Mobile Home Parks, N.Y. Real Prop. Law § 233</p>	<p>Contains specific provision warranting habitability of premises and requiring that landlord provide maintenance and rectify disruption of</p>	<p>Yes (N.Y. Real Prop. Law § 233(e)(4))</p>	<p>Yes (N.Y. Real Prop. Law § 233(n) & (f) (written and reasonable rule requirements))</p>

		services; no mention of natural conditions or specific remedies other than suit for damages (N.Y. Real Prop. Law § 233(m))		
North Carolina	Contains provisions saying general landlord tenant law applies to mobile homes, <i>see, e.g.</i> , N.C. Gen. Stat. Ann. § 42-36.1	No	General provision with broad grounds for eviction (N.C. Gen. Stat. Ann. § 42-26)	General provision stating certain activities protected by law (N.C. Gen. Stat. Ann. § 42-37.1)
North Dakota	One provision dealing with mobile homes but very few protections, N.D. Cent. Code Ann. § 47-10-28	Permissive statute allowing mobile home owners to construct a storm shelter (N.D. Cent. Code Ann. § 47-06-04.1)	No	No
Ohio	Manufactured Homes Oh. Stat. § 4781	Several provisions deal with possibility of flooding and require notifying the health board to enable inspection and altering/repairing park to comply with flood plain management rules (Oh. Stat. §§ 4781.32, 4781.33, 4781.34)	Yes (Oh. Stat. § 4781.37)	Yes (Oh. Stat. § 4781.36)

Oklahoma	Applies general residential landlord tenant act to mobile homes, 41 Okla. Stat. Ann. § 102 (defining dwelling unit to include manufactured or mobile homes)	Requires disclosure of past flooding problems (41 Okla. Stat. Ann. § 113a); allows tenant to obtain utility services or procure reasonable substitute housing at landlord's expense when there is no running water, hot water, heat, electric, gas or other essential service (41 Okla. Stat. Ann. § 121)	Yes (41 Okla. Stat. Ann. § 132)	No
Oregon	Manufactured Dwelling and Floating Home Spaces Or. Stat. § 90.505 et seq.	Yes, has specific provision dealing with manufactured dwelling parks affected by natural disaster and providing remedies to tenant (Or. Stat. § 90.640)	Yes (Or. Stat. § 90.630)	Yes (Or. Stat. § 90.765)
Pennsylvania	Manufactured Home Community Rights Act 68 Pa. Cons. Stat. § 398.1 et seq.	No	Yes (68 Pa. Cons. Stat. § 398.3)	Yes (68 Pa. Cons. Stat. §§ 398.16 & 398.16.1)
Rhode Island	Mobile and Manufactured Homes R.I. Gen. Laws § 31-44-1 et seq	Yes; requires owners to maintain all rented mobile homes rented in condition which is structurally sound/capable of withstanding weather conditions;	Yes (R.I. Gen. Laws § 31-44-2)	Yes (R.I. Gen. Laws § 31-44-5)

		maintain utilities and provide temporary provisions of service in case of emergency (R.I. Gen. Laws § 31-44-7)		
South Carolina	Manufactured Home Park Tenancy Act, S.C. Code Ann. § 27-47 et seq. Residential Landlord Tenant Act also applies to mobile homes if not inconsistent with this act; see S.C. Code Ann. § 27-40 et seq. and § 27-47-110	Yes; general provision requires landlords to make running water and reasonable amounts of hot water and heat available at all times (unless utility is under the exclusive control of the tenant) (S.C. Code Ann. § 27-40-440)	Yes (S.C. Code Ann. § 27-47-530)	Yes but only protects tenants retaliated against for complaining about conditions (S.C. Code Ann. § 27-40-910 + § 27-40-910 (stating this provision applies to mobile homes))
South Dakota	No - one provision within general landlord tenant act	No	No (S.D. Codified Laws § 43-32-31)	Yes (S.D. Codified Laws § 43-32-37)
Tennessee	Has adopted Uniform Residential Landlord Tenant Act Tenn. Code Ann. tit. 66, ch. 28	General provision providing tenants with remedies for landlords' failure to provide essential services (Tenn. Code Ann. § 66-28-502)	No	Yes (Tenn. Code Ann. § 66-28-514)
Texas	Manufactured Home Tenancies Tex. Prop. Code Ann. § 94.001 et seq.	No - landlord does not need to provide utilities if there is a reasonable cause of outage (Tex. Prop. Code Ann. § 94.153)	No - generally allows termination for any lease violation (Tex. Prop. Code Ann. § 94.205 & .206)	Yes (Tex. Prop. Code Ann. § 94.251)

Utah	Mobile Home Park Residency Act, Utah Code Ann. § 57-16-1 et seq.	No	Yes (Utah Code Ann. § 57-16-5)	Yes (Utah Code Ann. § 57-16-16(11)(a))
Vermont	Mobile Home Parks, Vt. Stat. Ann. § 6201 et seq.	Specific provision warrants habitability of park by requiring park owner to provide adequate and reliable utility services, including "safe electrical power, potable water, sewage disposal" (Vt. Stat. Ann. § 6262)	Yes (Vt. Stat. Ann. § 6237)	Yes (Vt. Stat. Ann. § 6247)
Virginia	Manufactured Home Lot Rental Act, Va. Code Ann. § 55.1-1300 et seq.	General provision requiring that the owner "[s]upply running water and reasonable amounts of hot water at all times and reasonable air conditioning if provided and heat in season" except where the tenant has exclusive control of the utilities or utilities are supplied by a direct public utility connection (Va. Code Ann. § 55.1-1220); also provides remedy for wrongful failure to supply an essential service (Va. Code Ann. §	Yes (Va. Code Ann. § 55.1-1315)	Yes (Va. Code Ann. § 55.1-1314)

		55.1-1239)		
Washington	Manufactured/Mobile Home Landlord Tenant Act Wash. Stat. Ann. § 59.20.010 et seq;	§ 59.20.200 provides the tenants with a list of grounds to provide notice to the landlord - including failure to provide water, electricity, etc.; situations where the defective condition is hazardous to life; § 59.20.130 requires that the landlord prevent the accumulation of stagnant water and the detrimental effects of moving water when the condition isn't the tenant's fault § 59.20.230 allows termination for defective condition which cannot be remedied	Yes (Wash Stat. Ann. § 59.20.080)	Yes (Wash Stat. Ann. §§ 59.20.070(5) and 59.20.075)
West Virginia	House Trailers, Mobile Homes, Manufactured Homes and Modular Homes W.Va. Stat. § 37-15-1 et seq	Yes; general provision requires landlords to make running water and reasonable amounts of hot water and heat available between October 1st and April 30th (unless utility is under the exclusive control of the tenant) (W. Va.	Yes, but broadly allows eviction for "good cause" (W. Va. Code § 37-15-3)	Yes (W. Va. Code § 37-15-7)

		Code § 37-6-30)		
Wisconsin	No act specifically governing mobile homes; relevant provision located in "miscellaneous property provisions" - Wis. Stat. Ann. § 710.15; contains additional protections in regulations	Somewhat - general provision allows tenant to withdraw from rental premises if they become "untenantable" due to fire, water, or other casualty unless landlord promptly rectifies condition. The tenant isn't liable for rent after condition occurs (Wis. Stat. Ann. § 704.07)	Yes, although broadly allows termination for any breach of the lease (Wis. Stat. Ann. § 710.15(5m))	Yes; general prohibition on retaliation for residential tenants (Wis. Stat. Ann. § 704.45)
Wyoming	N/A tit. 31, art. 5 (title and registration); tit. 35, ch. 18 (mobile home warranties; including lessees' rights)	Section 35-4-224 eliminates the authority of the Department of Health to regulate the design and construction of sewage and water facilities in a mobile home park; can still regulate health of persons in the park and facilities upon completion	No	No

Appendix B: Proposed Updates to the Arizona Mobile Home Parks Residential Landlord and Tenant Act

Statute	Current Text	Proposed Text
<p>A.R.S. 33-1434 (A)</p>	<p>The landlord shall: 7. Provide a statement of proposed interruption of utility service to the tenants within a reasonable time frame except in the case of an interruption caused by an emergency. An emergency does not include any failure or refusal on the part of the landlord to fulfill the landlord's duties and obligations as specified in this section. A statement of proposed interruption of utility service may be provided by posting an announcement of the period of the interruption in a conspicuous place within the mobile home park or by individual delivery to each tenant.</p>	<p>The landlord shall: 8. Remedy any interruption of electrical service to tenants within four hours of the onset of the interruption. If electrical power cannot be restored within this time, the landlord shall provide tenants with commercial-generated electrical power until power is restored.</p>
<p>A.R.S. 33-1452 (F)</p>	<p>A person who owns or operates a mobile home park shall not:</p>	<p>A person who owns or operates a mobile home park shall not: 9. Prohibit a tenant from using alternative cooling methods, such as temporary window-mounted HVAC, wall-mounted mini-splits, commercial window coverings, and other sun barriers to prevent heat-related illness and death.</p>
<p>A.R.S. 33-1474</p>	<p>A. If contrary to the rental agreement or section 33-1434, the landlord deliberately or negligently fails to supply essential services, the tenant may give reasonable notice to the landlord specifying the breach under tenant's remedies. B. The rights under this section do not arise until the tenant has given notice to the landlord. Such rights</p>	<p>A. If contrary to the rental agreement or section 33-1434, the landlord deliberately or negligently fails to supply essential services, the tenant may give reasonable notice to the landlord specifying the breach under tenant's remedies. B. The rights under this section do not arise until the tenant has given notice to the landlord. Such rights do not arise if the condition was caused</p>

	<p>do not arise if the condition was caused by the deliberate or negligent act or omission of the tenant, a member of his family or other person on the premises with his consent.</p>	<p>by the deliberate or negligent act or omission of the tenant, a member of his family or other person on the premises with his consent. C. The landlord shall provide tenants with a list of cooling stations or shelters, provided by the local municipalities, to be used in case of an emergency. The list shall be updated and distributed to tenants annually, on the date of the signing of the tenant's lease. The landlord is not liable for the accuracy of the information provided by this list.</p>
<p>A.R.S. 33-1476 (D) (1)</p>	<p>D. Except as otherwise prohibited by law:</p> <p>1. If there is a material noncompliance by the tenant with the rental agreement, the landlord shall deliver a written notice to the tenant specifying the acts and omissions constituting the breach and that the rental agreement will terminate upon a date not less than thirty days after receipt of the notice if the breach is not remedied in fourteen days. If the tenant remedies the situation within the time specified in the notice, the landlord shall issue a notice to the tenant releasing the tenant from the termination of rental agreement notice.</p>	<p>D. Except as otherwise prohibited by law:</p> <p>1. If there is a material noncompliance by the tenant with the rental agreement, the landlord shall deliver a written notice to the tenant specifying the acts and omissions constituting the breach and that the rental agreement will terminate upon a date not less than (thirty) sixty days after receipt of the notice if the breach is not remedied in (fourteen) thirty days. If the tenant remedies the situation within the time specified in the notice, the landlord shall issue a notice to the tenant releasing the tenant from the termination of rental agreement notice. If the tenant does not remedy the situation within the time specified in the notice and the landlord proceeds with eviction, an addendum shall be added to the lease providing the tenant with an additional 60-day nonresident storage, with rents paid, to allow the resident to move their mobile home from the park.</p>
<p>A.R.S. 33-1476 (D) (4)</p>	<p>D. Except as otherwise prohibited by law:</p>	<p>D. Except as otherwise prohibited by law:</p>

	<p>4. If a tenant engages in repetitive conduct that is the subject of notices under this subsection, after two incidents of the same type documented by the landlord within a twelve month period or after receipt by the landlord of two written complaints from other tenants about the repetitive conduct within a twelve month period, the landlord may deliver a written notice to the tenant specifying the repetitive conduct and the documentation and advising the tenant that on documentation of the next incident of the same type final notice will be given and the rental agreement or tenancy will be terminated thirty days after the date of the notice.</p>	<p>4. If a tenant engages in repetitive conduct that is the subject of notices under this subsection, after two incidents of the same type documented by the landlord within a twelve month period or after receipt by the landlord of two written complaints from other tenants about the repetitive conduct within a twelve month period, the landlord may deliver a written notice to the tenant specifying the repetitive conduct and the documentation and advising the tenant that on documentation of the next incident of the same type final notice will be given and the rental agreement or tenancy will be terminated (thirty) sixty days after the date of the notice. If a tenant engages in repetitive conduct or noncompliance as described in the lease agreement or rules and regulations, and the landlord proceeds with eviction, an addendum shall be added to the lease providing the tenant with an additional 60-day nonresident storage, with rents paid, to allow the resident to move their mobile home from the park.</p>
<p>A.R.S. 33-1476 (D) (5)</p>	<p>D. Except as otherwise prohibited by law:</p> <p>5. If a tenant has been involved in three or more documented incidents of conduct of any type described in this section within a twelve month period, the landlord may deliver a written notice to the tenant specifying the conduct and the documentation and advising the tenant that on documentation of the next incident final notice will be given and the rental agreement or tenancy will be terminated thirty days after the date of the notice.</p>	<p>D. Except as otherwise prohibited by law:</p> <p>5. If a tenant has been involved in three or more documented incidents of conduct of any type described in this section within a twelve month period, the landlord may deliver a written notice to the tenant specifying the conduct and the documentation and advising the tenant that on documentation of the next incident final notice will be given and the rental agreement or tenancy will be terminated (thirty) sixty days after the date of the notice. If an additional incident occurs within the time</p>

		specified in the notice and the landlord proceeds with eviction, an addendum shall be added to the lease providing the tenant with an additional 60-day nonresident storage, with rents paid, to allow the resident to move their mobile home from the park.
A.R.S. 33-1476 (H)	H. If a change in use is intended for the land on which a mobile home park or a portion of a mobile home park is located and the landlord intends eviction of a mobile home tenant due to a change in use, the landlord shall notify all tenants in the park in writing that: 1. The change in use may subsequently result in the termination of a rental agreement. 2. The tenant being terminated due to the change in use will receive a one hundred eighty day notice before the actual termination of the rental agreement.	H. If a change in use is intended for the land on which a mobile home park or a portion of a mobile home park is located and the landlord intends eviction of a mobile home tenant due to a change in use, the landlord shall notify all tenants in the park in writing that: 1. The change in use may subsequently result in the termination of a rental agreement. 2. The tenant being terminated due to the change in use will receive a (one hundred eighty) three hundred and sixty five day notice before the actual termination of the rental agreement.
A.R.S. 33-1476.01 (A)	A. The landlord shall notify the director and all tenants in writing of a change in use at least one hundred eighty days before the change in use. The landlord may not increase rent within ninety days before giving notice of a change in use.	A. The landlord shall notify the director and all tenants in writing of a change in use at least (one hundred eighty) three hundred and sixty five days before the change in use. The landlord may not increase rent within ninety days before giving notice of a change in use.
A.R.S. 33-1476.01 (C) (1)	C. If a tenant is required to move due to a change in use or redevelopment of the mobile home park, the tenant may do any of the following: 1. Collect payment from the mobile home relocation fund for the lesser of the actual moving expenses of relocating the mobile	C. If a tenant is required to move due to a change in use or redevelopment of the mobile home park, the tenant may do any of the following: 1. Collect payment from the mobile home relocation fund for the lesser of the actual moving expenses of relocating the mobile home to a new location that is within a one

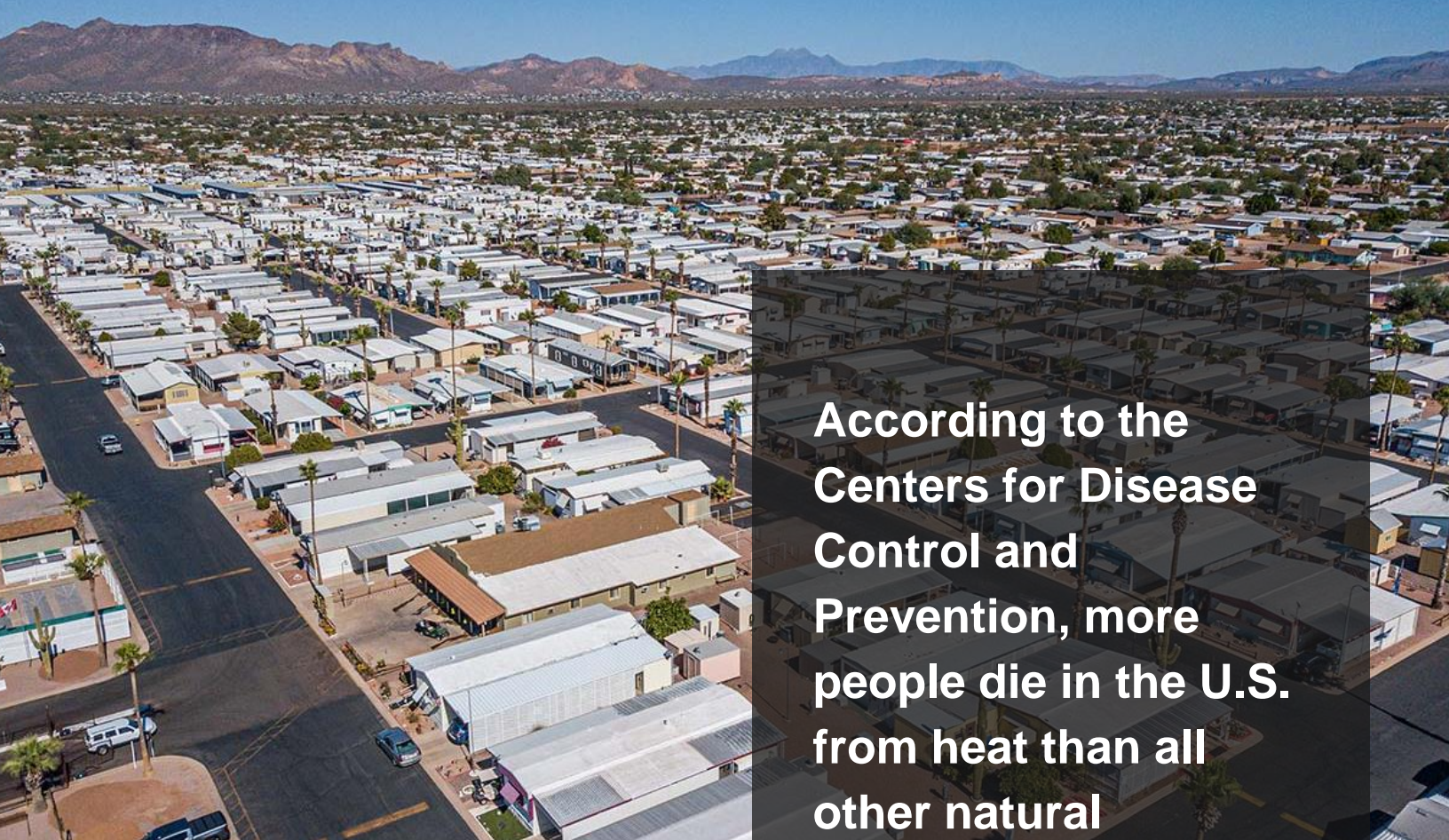
	<p>home to a new location that is within a one hundred-mile radius of the vacated mobile home park or five thousand dollars for a single section mobile home or ten thousand dollars for a multisection mobile home. Moving expenses include the cost of taking down, moving and setting up the mobile home in the new location.</p>	<p>hundred-mile radius of the vacated mobile home park or (seven thousand five hundred) fifteen thousand dollars for a single section mobile home or (twelve thousand five hundred) twenty thousand dollars for a multisection mobile home. Moving expenses include the cost of taking down, moving and setting up the mobile home in the new location.</p>
<p>A.R.S. 33-1476.01 (C) (3)</p>	<p>C. If a tenant is required to move due to a change in use or redevelopment of the mobile home park, the tenant may do any of the following:</p> <p>3. If a mobile home is relocated to a location outside of the vacated mobile home park and, in the sole judgment of the director, the mobile home was ground set in the mobile home park from which it was removed, the tenant may collect additional monies not to exceed two thousand five hundred dollars for the incremental costs of removing a ground set mobile home. These monies are in addition to any monies provided pursuant to paragraph 1 of this subsection.</p>	<p>C. If a tenant is required to move due to a change in use or redevelopment of the mobile home park, the tenant may do any of the following:</p> <p>3. If a mobile home is relocated to a location outside of the vacated mobile home park and, in the sole judgment of the director, the mobile home was ground set in the mobile home park from which it was removed, the tenant may collect additional monies not to exceed (two thousand five hundred) three thousand five hundred dollars for the incremental costs of removing a ground set mobile home. These monies are in addition to any monies provided pursuant to paragraph 1 of this subsection.</p>
<p>A.R.S. 33-1476.01 (D)</p>	<p>Except as provided in subsection C, paragraph 2 and subsection F of this section and section 33-1476.04, subsection D, if there is a change in use the landlord shall pay five hundred dollars for each single section mobile home and eight hundred dollars for each multisection mobile home relocated to the fund for each tenant filing for relocation assistance with the director.</p>	<p>Except as provided in subsection C, paragraph 2 and subsection F of this section and section 33-1476.04, subsection D, if there is a change in use the landlord shall pay (five hundred) one thousand dollars for each single section mobile home and (eight hundred) one thousand five hundred dollars for each multisection mobile home relocated to the fund for each tenant filing for relocation assistance with the director.</p>
<p>A.R.S.</p>	<p>E. If a change in use occurs before</p>	<p>E. If a change in use occurs before the</p>

<p>33-1476.01 (E) (1) (2)</p>	<p>the time stated in the statements of policy and the landlord does not comply with subsection A of this section and with section 33-1436 and section 33-1476, subsection H, the landlord shall pay to the fund in addition to the monies prescribed in subsection D of this section:</p> <ol style="list-style-type: none"> 1. Five hundred dollars for each mobile home space occupied by a single-section mobile home. 2. Eight hundred dollars for each mobile home space occupied by a multisection mobile home. 	<p>time stated in the statements of policy and the landlord does not comply with subsection A of this section and with section 33-1436 and section 33-1476, subsection H, the landlord shall pay to the fund in addition to the monies prescribed in subsection D of this section:</p> <ol style="list-style-type: none"> 1. (Five) Eight hundred dollars for each mobile home space occupied by a single-section mobile home. 2. (Eight) Eleven hundred dollars for each mobile home space occupied by a multisection mobile home.
<p>A.R.S. 33-1476.01 (G)</p>	<p>G. If a change in use occurs within two hundred seventy days after relocations under section 33-1476.04, the landlord shall pay to the fund in addition to the monies prescribed in subsection D of this section:</p> <ol style="list-style-type: none"> 1. Five hundred dollars for each mobile home space occupied by a single section mobile home. 2. Eight hundred dollars for each mobile home space occupied by a multisection mobile home. 	<p>G. If a change in use occurs within two hundred seventy days after relocations under section 33-1476.04, the landlord shall pay to the fund in addition to the monies prescribed in subsection D of this section:</p> <ol style="list-style-type: none"> 1. (Five) Eight hundred dollars for each mobile home space occupied by a single-section mobile home. 2. (Eight) Eleven hundred dollars for each mobile home space occupied by a multisection mobile home.
<p>A.R.S. 33-1476.01 (N)</p>	<p>N. After delivery of the one hundred eighty-day notice prescribed by subsection A of this section, the landlord and the tenants shall inform any prospective buyer or tenant that closure of the park is pending.</p>	<p>N. After delivery of the (one hundred eighty-day) three hundred and sixty five-day notice prescribed by subsection A of this section, the landlord and the tenants shall inform any prospective buyer or tenant that closure of the park is pending.</p>
<p>A.R.S. 33-1476.03 (A)</p>	<p>In order to provide monies for the mobile home relocation fund, each owner of a mobile home located in a mobile home park who does not own the land upon which the</p>	<p>In order to provide monies for the mobile home relocation fund, each owner of a mobile home located in a mobile home park who does not own the land upon which the mobile</p>

	<p>mobile home is located shall pay each year to the state an assessment equal to a rate of fifty cents per one hundred dollars of the taxable assessed valuation, derived by applying the applicable percentage specified in title 42, chapter 15, article 1 to the limited property value, for each mobile home the person owns.</p>	<p>home is located shall pay each year to the state an assessment equal to a rate of (fifty) seventy five cents per one hundred dollars of the taxable assessed valuation, derived by applying the applicable percentage specified in title 42, chapter 15, article 1 to the limited property value, for each mobile home the person owns.</p>
<p>N/A</p>	<p>N/A</p>	<p>The landlord shall provide to all tenants a plan for the sheltering or the safe evacuation to a safe place of cooling shelter of the tenants of the park in times of severe heat, defined as _____ temperature for _____ time period. The shelter or evacuation plan shall be developed with the assistance and approval of the municipality where the park is located and shall be posted at conspicuous locations throughout the park. The landlord shall provide each resident with a copy of the approved cooling shelter or evacuation plan. The municipality where the mobile home park is located shall adopt minimum standards for the construction of low cost mobile home park cooling shelters. All shelters constructed shall be constructed in accordance with these standards.</p>



Grantmakers in Aging Conference: ASU Mobile Home Heat Seminar



According to the Centers for Disease Control and Prevention, more people die in the U.S. from heat than all other natural disasters combined.

PART 1. PROBLEM:

Heat for elderly people in mobile homes

Most of what you'll hear today is focused on our local context here in Maricopa County, and the metro area around the City of Phoenix because it serves as a great example of the challenge of heat that is affecting the whole country. We're in the top 10 fastest-growing metro areas in the United States, and our county accounts for 61% of the state population providing a great wealth of data. We hope to show how what we have discovered - together between our university researchers and community partners can inform conversations towards solutions here and across the US.

While Arizona has always been known for its heat, the intensity, and frequency of this extreme heat are increasing, making it a shock our communities must respond to. In 2021, there were 126 days when the temperature was 100 degrees and over, and both the high and low temperatures for each month have increased substantially over the last century.

Over the last 20 years (2001-2021) in Maricopa County, 2,379 people have perished from heat-associated deaths. 861 of them, or 36%, happened in the most recent three years (2019-2021). Older adults are particularly vulnerable.

While people 65+ years old only make up 16% of the population, they account for 21% of outdoor heat deaths but a staggering 65% of indoor heat deaths.

What we discovered when asking “why indoors?” is that the type of housing matters. Another population that accounts for a disproportionately high amount of indoor heat deaths is mobile home residents. **Mobile homes account for 5% of the total housing stock in Arizona, yet mobile home residents historically account for 40% of indoor heat-associated deaths.**

It should be no surprise then, that people who fall in both of those categories at the same time - older adults living in mobile homes - are doubly vulnerable. **58% of heat-related deaths in mobile homes were people aged 65+** according to the data from the Maricopa county public health department. That means **an astounding 23% of indoor heat deaths were older adults living in mobile homes.**



This is Beverly. She is 65 and has been living in Arizona for 20 years but has never fully gotten used to Phoenix summers and the temperatures that go up to 120 degrees outside. It's getting harder with age for her to manage the heat and find ways to cool down.

Last year Beverly's neighbor, Helen, died from a heat stroke during a week that was particularly hot and humid. Beverly was lucky her son lives across on the other side of the metro area and was able to take her to stay at his house for 5 days when they saw the severe heat warning because he's able to keep his home cooler than she can.



So not only are older adults more vulnerable to the shock of heat because of age, but the way they may be exposed to that threat represents a critical risk - but it also represents an opportunity to act.

PART 2. EXPOSURE:

Built environment of mobile home parks

61% of all the mobile homes in Maricopa County were built prior to 1990, which is significant because that is when new energy efficiency standards went into effect for all new residential units.

Because the majority of mobile homes were constructed prior to that time, they typically have lower quality construction, including substandard appliances, plumbing, and lighting fixtures, as well as thin materials used for the walls, windows, and doors, resulting in poor insulation. As a result, mobile homes get hotter faster than traditional homes and can experience the same temperature inside and outside. Our team measured the temperature inside mobile homes during the survey and we registered 85°F and even hit a high of 111°F inside homes.



Beverly lives in the mobile home park in Mesa. This is her mobile home. It's not very big but the size suits her just fine and she likes the individual space it provides her. It was built around 1970 though, so it's been showing its age for a while now. And boy does it get warm inside! The insulation has never been very good, and it doesn't help that it sits in direct sunlight all day.

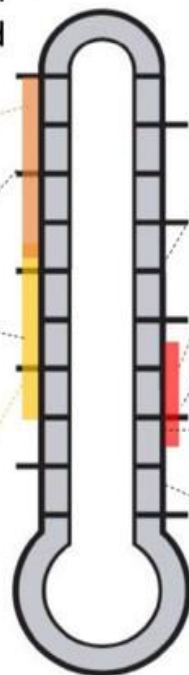


Land Surface Temperature at Research Site and in Phoenix during Study Period

- 112.0°F - 150.7°F Range of Land Surface Temperature at Study Site
- 131.3°F Average Land Surface Temperature at Study Site
- 96.6°F Average Official Temperature at Phoenix Sky Harbor Airport
- 78.8°F - 114.8°F Range of Official Temperature at Phoenix Sky Harbor Airport

Mobile Home Residents Recorded Indoor Thermal Exposure

- 111.2°F Maximum Indoor Temperature Recorded for any Participant
- 73.0°F - 94.7°F Range of Average Indoor Temperature Recorded across Participants
- 81.9°F Median among Participants of Average Recorded Indoor Temperature
- 76.4°F Average Preferred Indoor Temperature
- 64.9°F Minimum Indoor Temperature Recorded for any Participant



In mobile home communities, the residents typically own the home itself, but they nearly always rent the space of land under it - especially in cities. Here, most of the time, mobile homes are located in mobile home parks where a landlord owns all the land of the park and manages the community. Residents aren't typically allowed to plant trees or make significant changes to the landscape even if they could. Urban parks typically are fully paved and extremely dense.

Poor insulation means that older mobile homes require more energy, and are provided over a longer duration of time, to cool down the home compared to a well-insulated traditionally built home. This means a greater load on the electric grid and higher electricity bills for mobile home residents who choose to go that route.



Beverly would plant a tree for shade if it was allowed, but as it is, she's surrounded by asphalt that just heats up the air even more and holds the heat well through the night so she can't even expect to cool down through an open window at night. She doesn't have many options to cool down her home either. She bought one of the window AC units a few years ago, but it takes so long to make any difference and is such a pull on the electricity that she can only afford to use it sparingly.





Nearly 30% of mobile home residents here have a household income of less than \$25,000 per year.

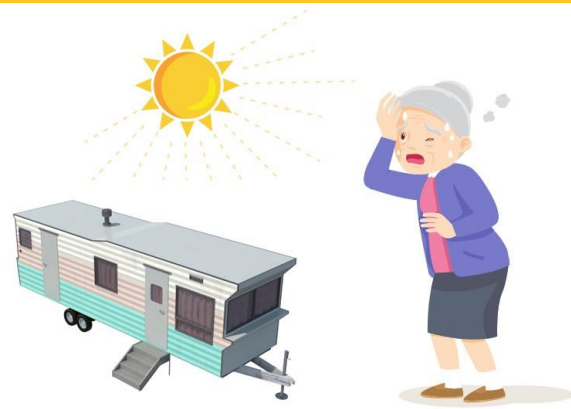
PART 3. VULNERABILITY:

Financial situation of the mobile home population

Many elderly mobile home residents are on a fixed income that comes from social security. However, the average annual cost of living in Phoenix is currently 3 times higher than the average annual income from social security retirement and disability benefits. Maybe you see this same thing happening in your community. While not all mobile home residents are lower income, **nearly 30% of mobile home residents here have a household income of less than \$25,000 per year**, and they are 3 times more likely to make less than that compared to residents of other types of residential units.

Mobile homes range in value and can even be worth as much as a traditionally built home; however, **the average value of a mobile home is only \$33,565 compared to the average value of \$261,793 for a single-family traditional home**. Despite this, the rent for each is almost exactly the same between **\$1,000-\$1,200 per month**.

We all know that rent has to be paid though. So even though their average income is significantly lower, and their housing value is significantly lower, they still have to pay the average rent and even higher utilities for the space. As a result, our survey research has shown **people living in mobile homes in Arizona are twice as likely to forego expenses for basic household necessities, like medicine or food, in order to pay their energy bill**. In fact, **almost 11% of mobile home households have had trouble paying their energy bill every month in the last 12 months compared to 5% of other housing units**.



It was easier before Beverly's husband passed away. Their combined income was enough that together they could afford to run the AC every day. But since he's been gone, Beverly has had to really cut back and stick to a tight budget.

Beverly's income now is a fixed \$33,000 per year from social security. By budgeting very carefully she's managed to get her basic living expenses to around \$28,000 per year, but that doesn't leave much for the little luxuries like running her AC unit. She usually only turns it on in the afternoon, and even then she has the thermostat set at 78 degrees, but the average temperature in her unit is around 80 degrees. Just enough to take the edge off.

We mentioned before that mobile home residents account for 40% of indoor heat-related deaths, and this inability to afford the electricity needed to cool down a poorly insulated mobile home is one major reason for that disparity. Mobile home residents that perished due to indoor heat were twice as likely as their neighbors to not have an AC unit in their home, and even those that did have an AC unit were three times more likely to not have electricity turned on in their home due to unpaid utility costs.

This inability to afford AC creates a much higher exposure to the shock of heat, and older adults are particularly vulnerable both due to physical conditions and the likelihood that they are on a tight fixed income. These findings help explain why we see such a disproportionate number of deaths resulting from indoor heat exposure among older mobile home residents

Those that perished are twice as likely to have no AC unit.

40%

of Indoor Heat Deaths are in Mobile Homes

11%

have had trouble paying their energy bill

Those that have an AC unit are three times more likely to have no electricity to due unpaid utilities.



**What about solutions?
Let's zero in on three
of the general
problems and some of
the solutions we have
co-designed with our
stakeholders.**

PART 4. ADAPTABILITY:

Solutions on different scales

For our communities to be resilient, they need to be able to adapt in response to the shocks they are exposed to. What we just heard of Beverly are various attempts at adaptation from the larger community. Having her son nearby as a support system was a great benefit for her, but one that is not available to everyone in her position. So what are ways the larger external community can adapt to support the older mobile home community?

One way the larger community provides adaptive capacity is through the provision of built environment resources and regulations that encourage that they are affordable and accessible to those who need them the most.

Landlords of housing units in general are required to provide a safe living environment, however, because of the interesting dynamic in mobile home parks where the home itself is typically owned by the occupant and just the land is rented, it is complicated to determine what a mobile park landlord is - or should be - required to provide. So far they are not required to provide any amount of shade cover or any type of community cooling station, and there are no legal or financial incentives for them to do so.



Scale: Landlord

All our stakeholders can mobilize and implement solutions on different levels. For example, our law and policy team, together with residents, have identified the solution that landlords of mobile home parks could offer, under the heading of a safe environment, parkwide access to an onsite cooling shelter on days exceeding a certain temperature.

In addition, they could install an alert system to check in on residents. Our engineering students are building prototypes of early warning systems that can be installed in the home to alert relatives, caregivers, and park managers when the indoor temperature has exceeded a safe level. When alerted, they can help residents in time and save their lives by moving them to a cooling station.



Beverly was thankful that her son was able to take her in when it got super bad last year, but she knows that won't always be possible, so she wants to find ways to make her own home livable in the summer. Unfortunately, she feels that it may be impossible. She looked into getting financial assistance with her electricity bill through the national LIHEAP program, but because she lives in a mobile home, she isn't eligible. She heard the city has a tree program to help create shade and provide natural cooling, but since she just rents the space, she isn't allowed to plant anything. Not that there is anywhere she could have planted it anyway, with all the asphalt covering the ground. She even reached out to the landlord a few times about the possibility of creating a cooling shelter for the community, but she has not yet heard back.

Scale: City

On the city level, we can increase the number of cooling stations and strategically place them near mobile home parks. And landlords can provide tenants with a list of the closest cooling stations to be used in case of an emergency along with shuttles for those who are less mobile.

Our team of geographers has been providing analysis towards this solution for the City of Phoenix. As a result, we created an optimization model that allowed us to distribute additional cooling stations in close proximity to the mobile home parks.

To make this possible across the entire state of Arizona, we have begun to try to locate all mobile homes and parks. Unfortunately, we found out that there are no comprehensive and accurate databases available to demonstrate all locations. So our computer science and urban planning team activated an app on your phone called MapSwipe which enlists hundreds of volunteers from anywhere to review satellite imagery to find them visually. This tool is supported by the American Red Cross. Through these crowdsourcing efforts, we already found, identified, and added over 3,000 mobile homes to the map.

Existing and new cooling centers optimization, Maricopa county, 2020

Cooling centers optimization accounting for the existing

Optimized cooling stations (accounting for the existing)



0.5 mile buffer zone



2020 Existing cooling stations



2019 Heat Refuge Centers



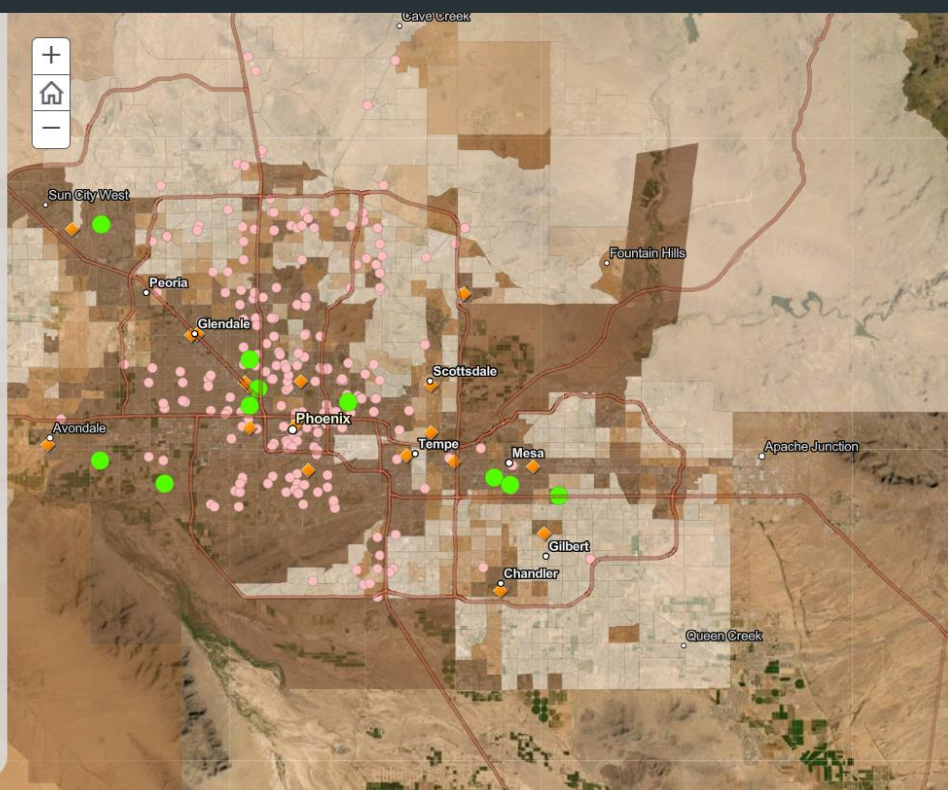
Social Vulnerability Index (SOVI)

SUMM

> 90

75

< 60



Scale: City

Another aspect of our efforts to engage city officials about the vulnerability of older mobile home residents is to support the expansion of existing cooling programs. For example, the Mesa fire department had been distributing water during extreme heat days but had not been going into the parks because they are private property and need permission to enter. After city officials realized the extreme vulnerability in parks from our research, they grew their outreach to enter parks and distributed water to 8,000 mobile home residents.

Similar to the tree program, cities can develop a “shade sails” program and financially incentivize residential communities to have certain levels of shade cover including private properties such as mobile home parks. Even though some cities have such programs, mobile home residents are usually falling between the cracks because of the ownership of the park, and some of the restrictions we have heard from residents on putting up shades. As a result of our research, and the efforts of AAMHO, some residents have been able to work with their landlords to raise sails for the summer months.



Scale: City to Region

At the regional level, there is also a need for fostering energy solutions for mobile home customers, working around the unique challenges of park residents who receive electricity through the master meter meaning they may not be direct customers who can take advantage of existing support programs. Utility companies are exploring low-cost, energy-efficient, and renewable options, For example, SRP and APS jointly offered mobile home workshops. SRP has provided us with data that is helping us develop new park energy models with ASU's power labs. APS offers community solar programs, whose viability with mobile home parks we are also researching.

Another way the larger community provides adaptive capacity is through financial assistance programs. Most households are able to apply for the federal "Low Income Home Energy Assistance Program", LIHEAP, when they are struggling to pay their electricity bill, however the way the federal program is currently written, mobile home units are not eligible. There's also not enough to meet the demand so these resources need to be expanded as well.

Scale: State to Federal

What could be possible if all the hot weather states band together to get the federal LIHEAP extended to include mobile home residents? Or at least extended to those receiving social security? To plant this seed, we presented our research to our Senator's science officers in Washington DC.

Scale: Federal

Or, since more people die in the U.S. from heat than all other natural disasters combined, what if FEMA declared heat as an eligible hazard, like hurricanes and floods, so that they could then be able to mobilize their resources to respond? To plant this seed, we organized a nationwide webinar with and for FEMA's Resilient Nation Network, to bring attention to this gap.



PART 5. ADAPTABILITY:

Allow the mobile home population to adopt solutions themselves

Earlier we were discussing ways the larger community can provide adaptive capacity to those vulnerable to the shock of heat, whereas here Beverly starts addressing ways that the individuals impacted can themselves adapt to become more resilient in the face of the shock.

Our team has been doing work in this space for over 4 years now, and we've compiled a diverse toolkit of different ways mobile home residents can heat-proof their homes, which we call the "Mobile Homes Heat Solutions Guide" and have been distributing throughout the community. Please feel free to take one with you, too.

The existence of the solution guide has been a source of knowledge for the community to respond, adapt and implement solutions. The tools include reflective window coverings like in Beverly's story. This toolkit includes 50 solutions to mitigate heat that are divided into 5 groups: technical and built solutions, natural solutions, policy-related, equity efforts and social/community programs, innovative financial products, and opportunities.

The private sector is also a source of solutions. One particularly exciting tool has come out of a partnership with 3M and SkyCool. They have designed an experimental roofing product that helps keep homes cooler by rejecting heat. It's still in the experimental phase, but we were excited to complete the first pilot test mobile home installation of the product this summer and are attentively analyzing the internal and external temperatures to see how it performs. Working closely with our community members made this possible. We hope to do more experiments next summer.

As the story of Beverly's friend illustrates - sometimes landlords prohibit the use or installation of alternative cooling methods. If we are going to have any success in deploying these alternative cooling methods and thereby reduce heat-related death, mobile homeowners must be allowed to decide for themselves to install any of these life-saving options in their homes, and we need to ensure that they cannot be prohibited.

Our law school team has been working closely with AAMHO to analyze the "Mobile Home Landlord & Tenant Act" for updates that make this clear and protect the right of mobile homeowners to utilize methods proven to protect against heat-related illnesses and death in their own homes. And in fact, our community partner the Arizona Housing Coalition has organized a workshop with Community Legal Services about the Mobile Home Landlord & Tenant Act, which will be taking place next week.



Even though she can't afford to run it all the time, Beverly is thankful her landlord has allowed her to keep her window AC unit. She has a friend in the park across the street that had finally saved up and purchased one, just for the landlord to say she had to remove it as soon as she set it up. He said the look of it didn't comply with the park rules and she could be evicted. Beverly wasn't sure if he could really do that, but her friend was too worried about being evicted to risk upsetting him by fighting it.

Beverly meanwhile, had started looking into other ways to improve her home to protect against the heat, so the AC - and her electric bill - wouldn't have to carry the full burden. She thought she was on to something when she heard of a reflective film you could put in your windows that was supposed to result in less heat getting in, but neighbors complained about the film and she had to remove it."



We are often asked, “why should we fix this housing that gives rise to so many problems and instead just move this vulnerable population to safer housing?”

PART 6.

Affordability of housing stock and livability of mobile homes

But mobile homes are already considered one of the most accessible and affordable types of housing options in a city that is experiencing shortages and stark growth.

Our team has data science and sociology expertise, so we have been tracking the number of evictions over the last few years, including during the pandemic. Our monitoring dashboard revealed that here in July 2022 the number of evictions was higher than at any time since the housing crisis of October 2008. And this number has continued to climb since then. But people have few places to go. Arizona homeowner and rental vacancy rates have been decreasing since 2008.

As a result, since 2010, there has been a huge availability gap in the housing stock in Arizona. The projected growth equals 80,000 – 90,000 new residents each year. And to get supply and demand back into balance over the next 5 years we need an elevated total of about 40,000 new housing units per year.

The housing in Arizona is getting old but new housing is not keeping up with the demand. Thus, on a big scale, we need to improve the affordability of housing and livability of the existing housing like mobile homes, to address the vulnerability of the older adult population. And heat-associated deaths among people experiencing homelessness account for nearly half of all outdoor heat-related deaths in Maricopa County, so we need to keep people in their homes.





While we have been focusing our attention on Arizona, heat is becoming a major challenge across the nation. And it's only getting hotter.

PART 7.

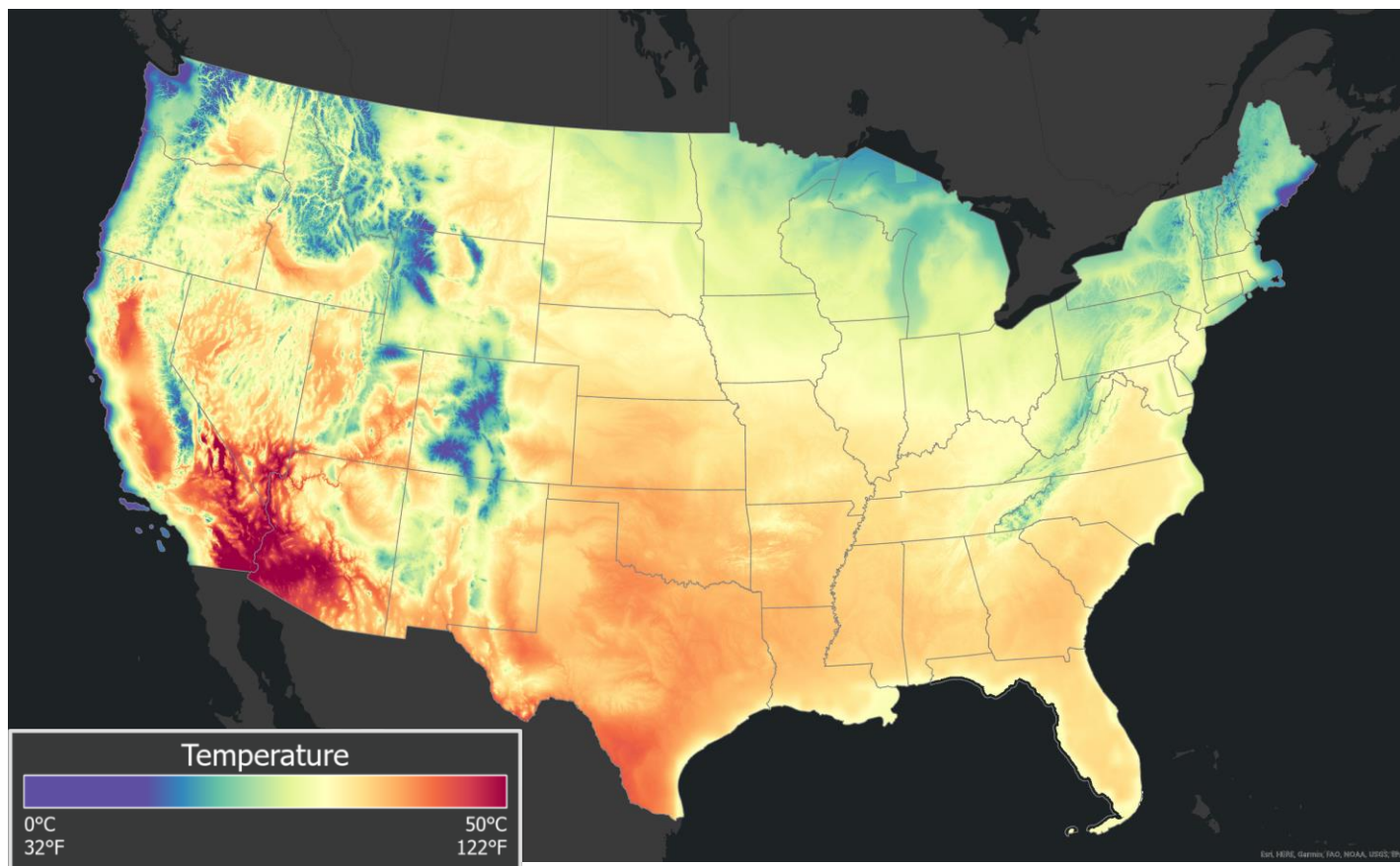
National level importance

In the next 30 years, it's estimated that 2/3 of the US population will be at risk due to extreme heat. America is also getting older. The portion of our population aged 65+ will be increasing, meaning more people are becoming more vulnerable even as the shock increases.

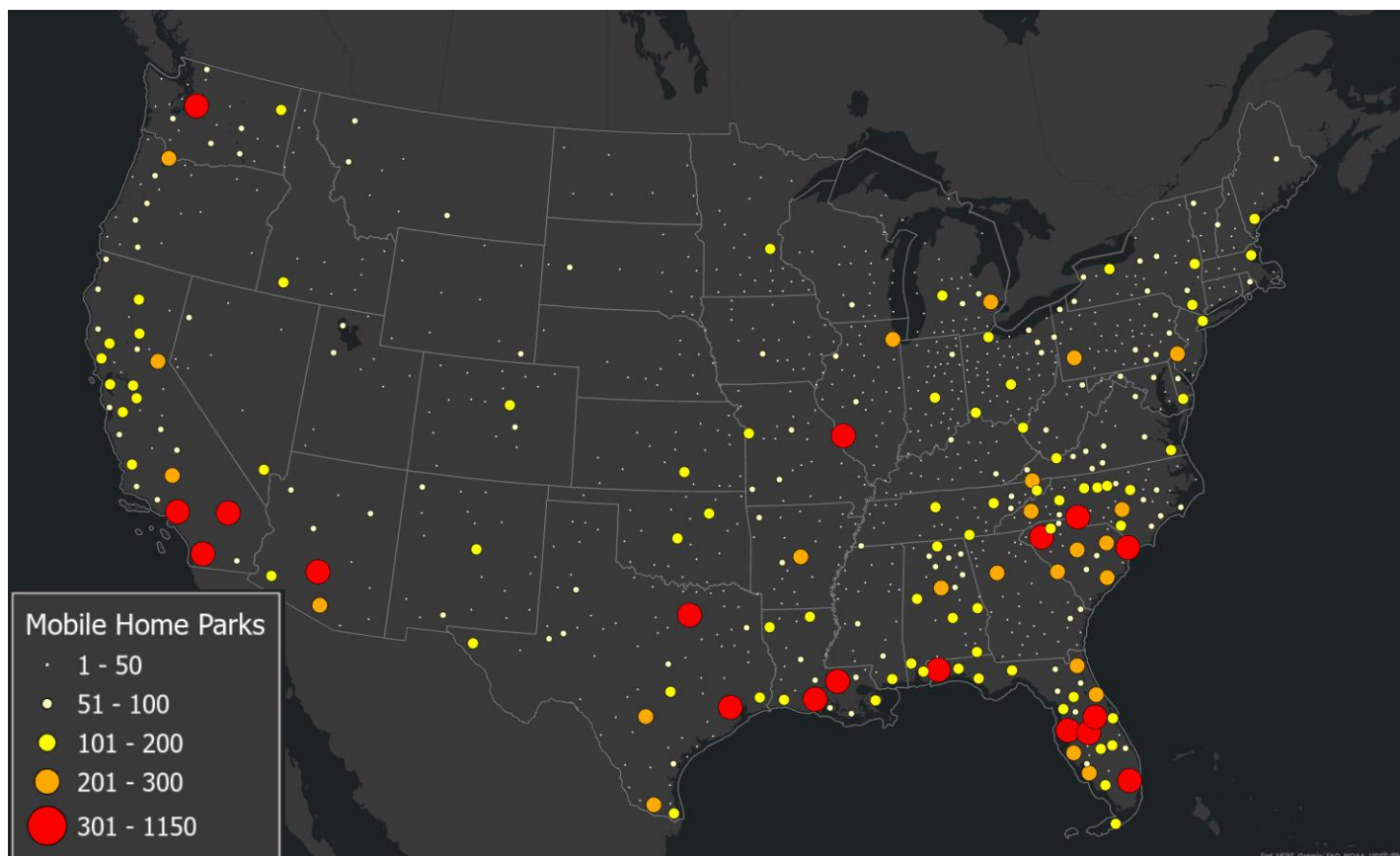
By 2060, nearly 1 in 4 Americans will be age 65+

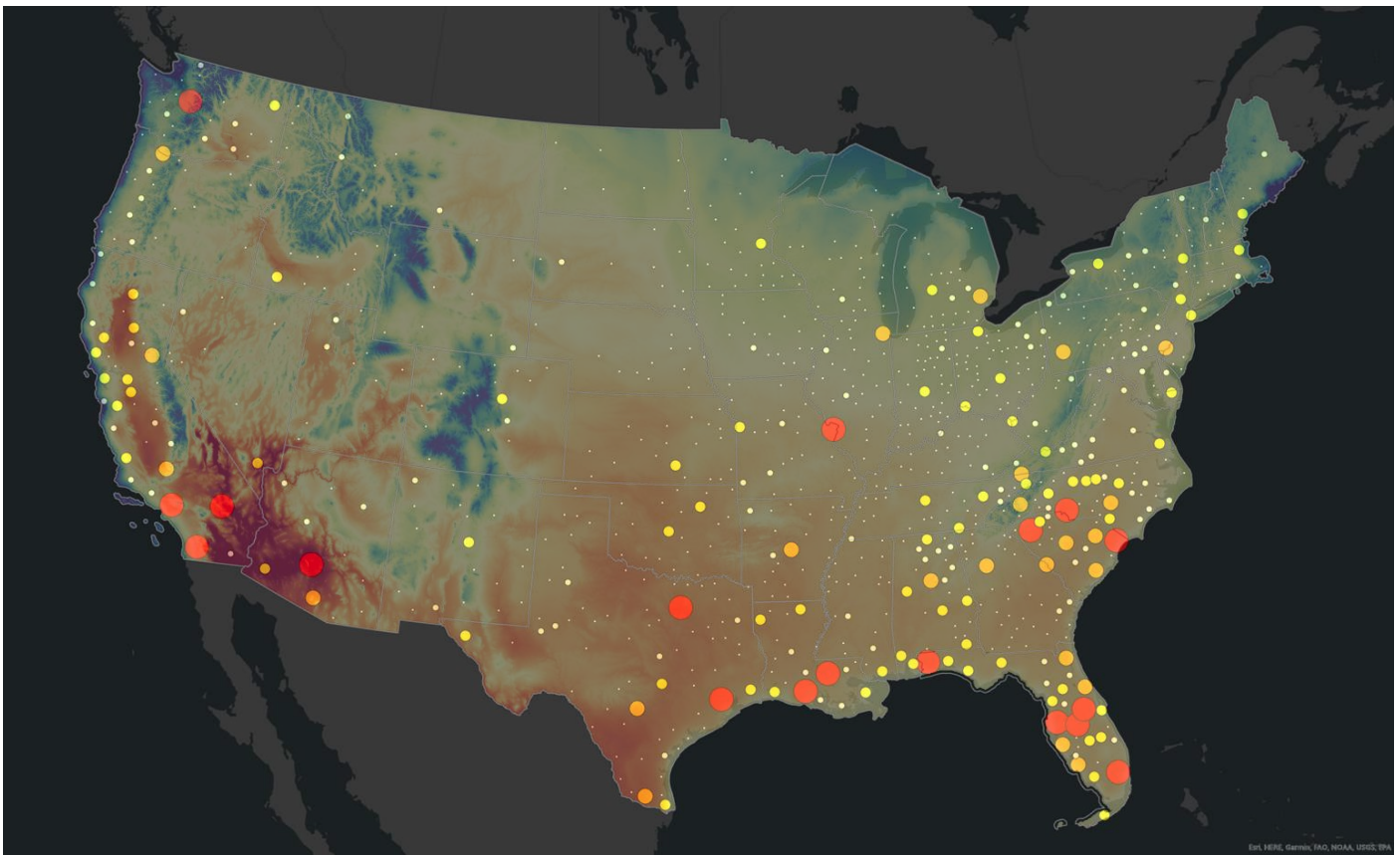
Right now that age group is only 16% of the population, yet still account for 65% of indoor heat deaths

Temperature projection, 2022 - 2100



Mobile Home Concentration, 2020





Let's overlay those maps of heat increase and mobile home park locations. It's not a pretty picture.

As of February 2022, approximately 3.2 million people aged 60 and older reported living in a mobile home according to Census. This is 4% of all older adults in the country living in mobile homes.

People living in mobile homes are already 6 to 8 times more likely to die of heat-related causes. We expect that will only continue to increase unless we are able to substantially change the average mobile home experience. At the rate of growth of older adults in the US, and facing a warming planet, we project that **67 Million older adults across the country will find themselves at risk of extreme heat exposure by 2060. 16 Million of them may live in mobile homes by then.** Without action, more than **38 thousand older adult mobile home residents would perish from the heat in the years ahead by 2060.**

We need to address this problem on the national level.



PART 8. HOPE:

Such change is possible

And that large-scale change is possible. As a result of this kind of engagement - universities and community stakeholders engaged around problems of resilience together, we can zero in on the kinds of tools and solutions that might break down the silos. When we share data and questions, discover hidden vulnerabilities and opportunities, then seek multiple layers and levels of solutions, our communities, like the older adult mobile home residents, will no longer fall between the cracks. Working together and sharing our collective knowledge with one another can lead to real change and greater resilience. We invite you to be a part of that process - whether that is finding one of the solutions that you can own - or finding new partnerships to scale up your impact.

Her landlord also improved the environment of the park: they planted more trees and vegetation and added shade sails and misters during summer. An early detection system was installed in each house so if it gets too hot inside the mobile home, the park manager can check on the resident and help her to go to the cooling center on the site of the mobile home park. All these improvements made the mobile home park a safer environment during extreme heat.


As for utilities, thanks to a new utility conversion program all mobile homes are now submetered at the individual dwelling level. In addition, utility assistance programs, policies and regulations were modified to include mobile homes and make them eligible, and her park signed on to the Solar Communities program, so Beverly's energy bill is only a fraction of what it used to be and sometimes she gets the credit. The State of Arizona also drafted statewide legislation protecting against blackouts and incentivizing renewable energy, especially in parks

The County and the City worked together to improve the cooling centers' network by increasing their numbers in close proximity to mobile home parks and subsidizing transportation options to get there. Wellness checks and community engagement programs were expanded with help from the insurance industry.



Just 5 years later... Thanks to mobilizing solutions around the older adult population living in mobile homes Beverly's life at age 70 has improved significantly. You can see the picture of the mobile home park she is living in now. She received money from a new "Heat Adaptation" fund to fix her mobile home and make it more resilient to heat by air sealing the house, adding skirting, shade awnings, and reflective coating, with no prohibitions from park rules. She also got new cooling equipment. Thanks to this her house doesn't get as hot anymore and she can easily maintain 75 degrees inside in summer.

Meanwhile, her son got a new higher paying job even closer to where she lives - working at the new manufacturing plant that is building "Heat Smart Manufactured Homes" established to create economic development and close the housing affordability gap!



Thanks to this multi-level, multi-sector, systems change, Beverly now has reduced her vulnerability, minimized her exposure, and expanded the social network that can support her during the shocks of extreme heat. Our own community is reaping the dividends.

Designing Resilience Dividends

Heat Resilience among Older Adult Residents of Mobile Homes

We were excited to host you at the ASU Walton Center for Planetary Health main auditorium, to share your insights and experience in a seminar that showcases community–university partnerships to build community resilience to the shock of heat. The research narratives represent more than four years of knowledge exchange around heat resilience, particularly discovering together some of the hidden vulnerabilities among our older adult population who reside in mobile and manufactured housing. Our work also suggests solutions, some that partners have begun to mobilize. Join us to learn more, take part in the discussion, and resolve to take actions informed by the data created through our university and community partnerships.

Acknowledgments

Arizona State University's four campuses are located in the Salt River Valley on ancestral homelands of indigenous peoples, including the Akimel O'odham (Pima), Pee Posh (Maricopa) and Tohono O'odham communities, whose care and keeping of these lands allows us to be here today. We pay our respects to their Elders past and present.

Core Event Production Team

Chelsea Dickson, visualization and projection; Kate Varfalameyeva, research narratives and script; Elisha Charley, research and data analysis; Giovanna Arenas, logistics.

See also the full list of study team members below.

With Gratitude to our Joint Community and University Research Team

ASU – Knowledge Exchange for Resilience

- Abdulrahman "Al" Alsanad, GIS Analyst
- Giovanna Arenas, Events Coordinator
- Susana Bustillos, Assistant Director
- Elisha Charley, Graduate Research Assistant
- Melissa Guardaro, Associate Research Professor
- Christina Hernandez, Partnership Manager
- Abigail Johnson, Communications Director
- Brajesh Karna, Data Manager
- Nicholas Kenney, Student Research Aide
- Claire Nelson, Student Research Aide
- Lora Phillips, Assistant Research Professor
- Sarbeswar Praharaj, Assistant Research Professor
- Negar Rahmatollahi, Graduate Research Aide
- Maryam Shafiee Shakib, Graduate Research Assistant
- Patricia Solis, Executive Director
- Kate Varfolomeyeva, Research Manager
- Libby Wentz, Director, Professor

Arizona State University Departments and Centers

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- Shea Lemar, Director, Geospatial Research and Solutions
- James Ruberto, Research Specialist, Geospatial Research and Solutions
- Lauren Kuby, Stardust Center
- Jenni Vanos, Associate Professor, School of Sustainability
- Di Bowman, Professor, Sandra Day O'Connor College of Law
- Bryan Hull, Specialist, College of Law

AAMHO

- Pat Schoneck, President
- Pat Sunia, District 1 Director
- John Hoppin, District 2 Director
- Connie Hancock, Office Manager
- Mary Alice Theroux, Legislative Associate Director
- Many other past board members and local member residents

Additional Community Partners

- Emily Mead, Piper Trust
- Stacey Easterling, Piper Trust
- Dana Kennedy, AARP Arizona
- Dave Hondula, City of Phoenix
- Mary Wright, City of Phoenix
- Teresa Sosa, Salud en Balance
- Eli Goldstein, SkyCool
- Billie Pritzker, 3M
- Brian Howland, bluemia
- Cynthia Zwick, Wildfire
- Joanna Carr, Arizona Housing Coalition
- Joan Serviss, Arizona Housing Coalition
- Aaron Gettel, Maricopa County Public Health Department
- Gail LaGrander, Maricopa County Public Health Department
- Vjollca Berisha, formerly Maricopa County Public Health Department
- Hank Courtright, SRP
- Christy Boos, SRP
- Susan Brenton, Manufactured Housing Communities of Arizona
- Serena Sowers, SwissRe
- Mark Kear, University of Arizona
- Jen Duff, Vice Mayor, City of Mesa
- Shelley Morgan, Arizona Department of Economic Security

Special thanks to the countless residents who have participated in surveys, heat sensor metrics, interviews, and product testing.

Video Credits

- Origins Documentary: Don Newlen, and Drew Moraca, Fervor Creative
- bit.ly/heatmobilehomes
- ABC 15 News : Decrease Heat Deaths in Trailers: Courtney Holmes bit.ly/abc15heat
- PBS Terra : America's Hottest City : Mayia May bit.ly/hottestusa
- CBS 5 Phoenix 3TV : Indoor Deaths Occur : Alexis Dominguez bit.ly/cbs5heatsolis22



The ASU Knowledge Exchange for Resilience is supported by Virginia G. Piper Charitable Trust. Piper Trust supports organizations that enrich the health, well-being, and opportunity for the people of Maricopa County, Arizona.



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[asuresilience](https://asu.edu/asuresilience)



Grantmakers in Aging Conference: ASU Mobile Home Heat Seminar

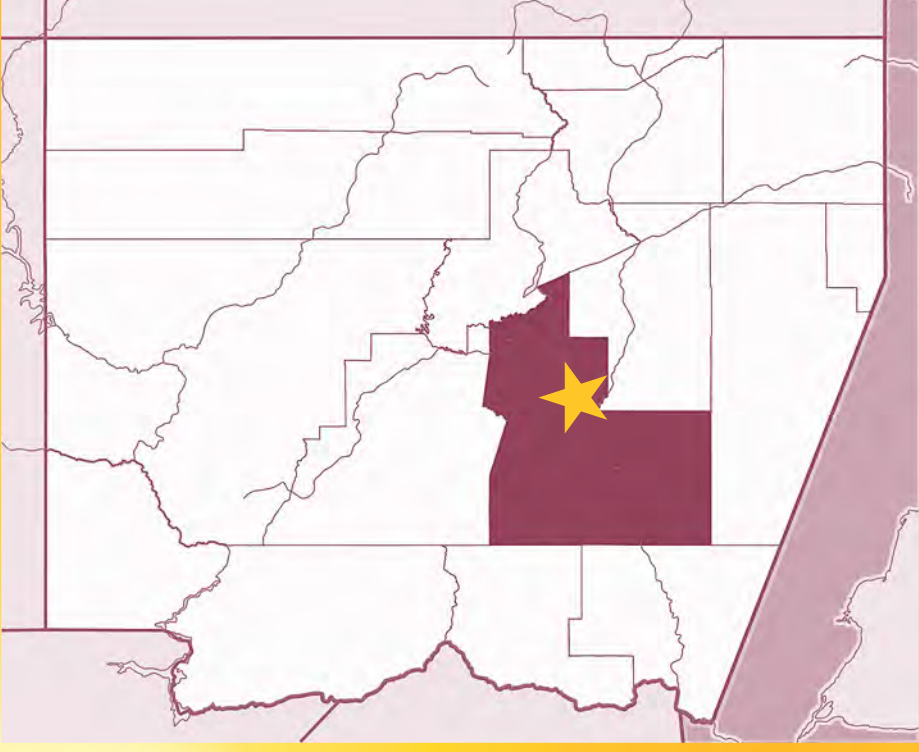


ASU Knowledge Exchange
for Resilience
Arizona State University

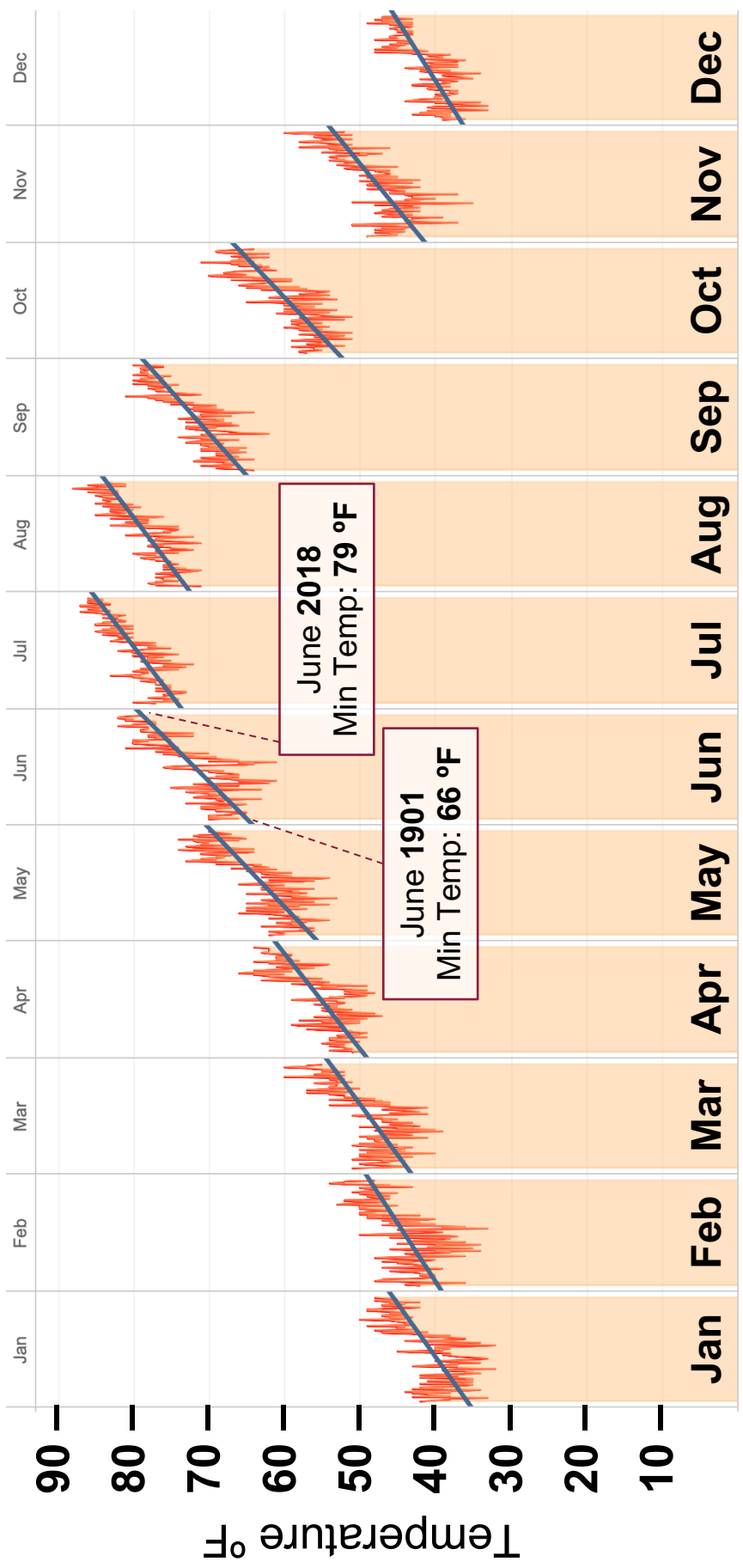
**More people die in the U.S.
from extreme heat
than from all other natural
disasters, combined.**

Why Focus Here?

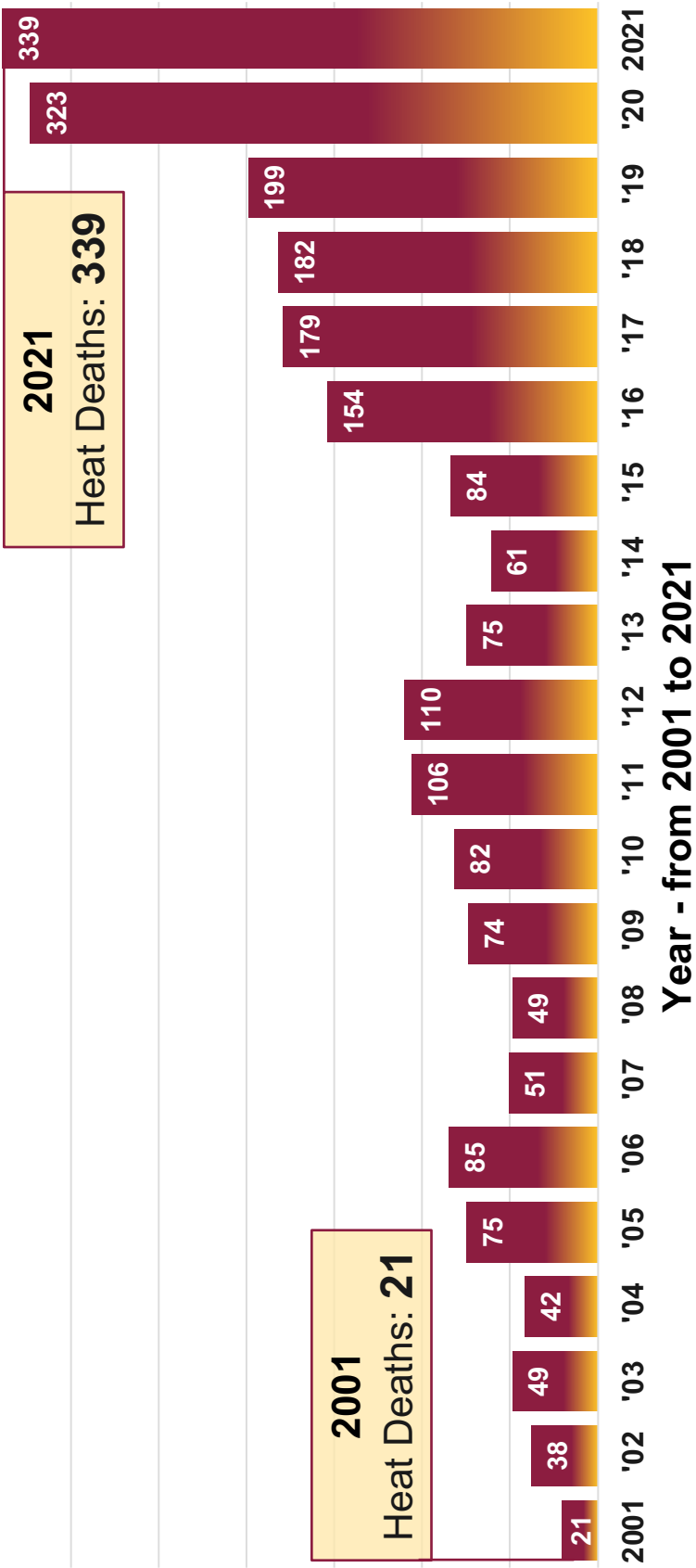
- Know extreme heat
- Maricopa County holds 61% of the state population
- Top 10 fastest-growing metro areas in the U.S.



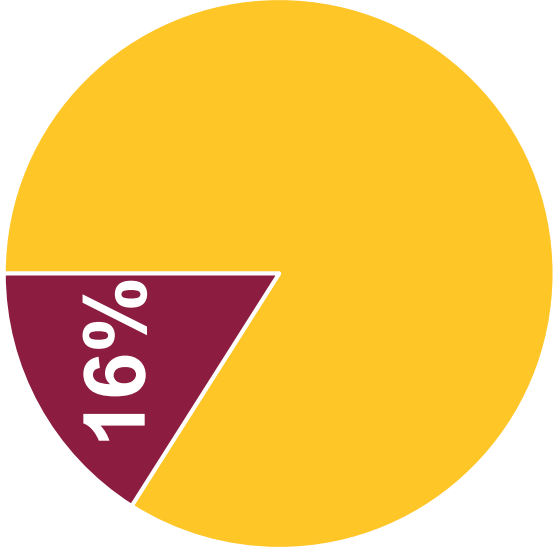
Average Minimum Temperature in Phoenix from 1900-2018, by Month



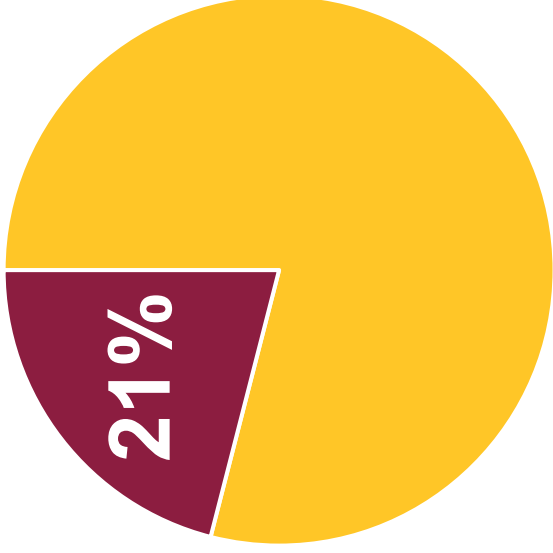
Heat-Associated Deaths in Maricopa County by Year



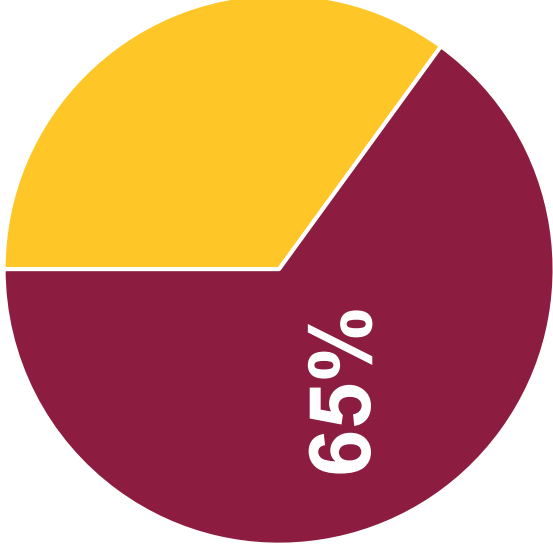
Percent of the Population Age 65+



**Total Maricopa
County Population**

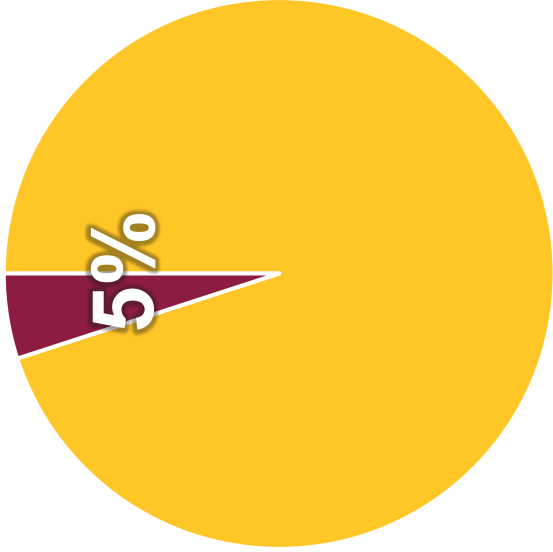


**Outdoor
Heat Deaths**

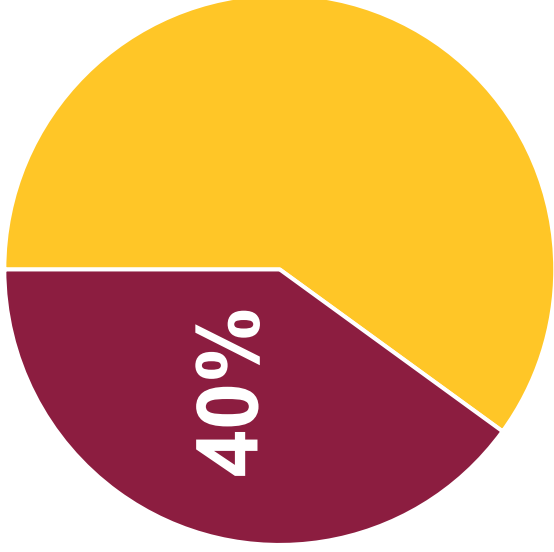


**Indoor
Heat Deaths**

Percent Mobile Homes



Total Housing
Stock in Arizona



Indoor
Heat Deaths

23%

of Indoor Heat
Deaths are
adults aged
**65+ living in
Mobile Homes**

61% of all Mobile Homes
in Maricopa County
were built **prior to 1990.**

Land Surface Temperature

131.3 °F = Average at Study Site

112.0 – 150.7 °F = Range at Study Site

96.6 °F = Average Official Temperature at PHX Airport

78.8 – 114.8 °F = Range Official Temperature at PHX Airport

Indoor Mobile Home Temperature

111.2 °F = Maximum recorded

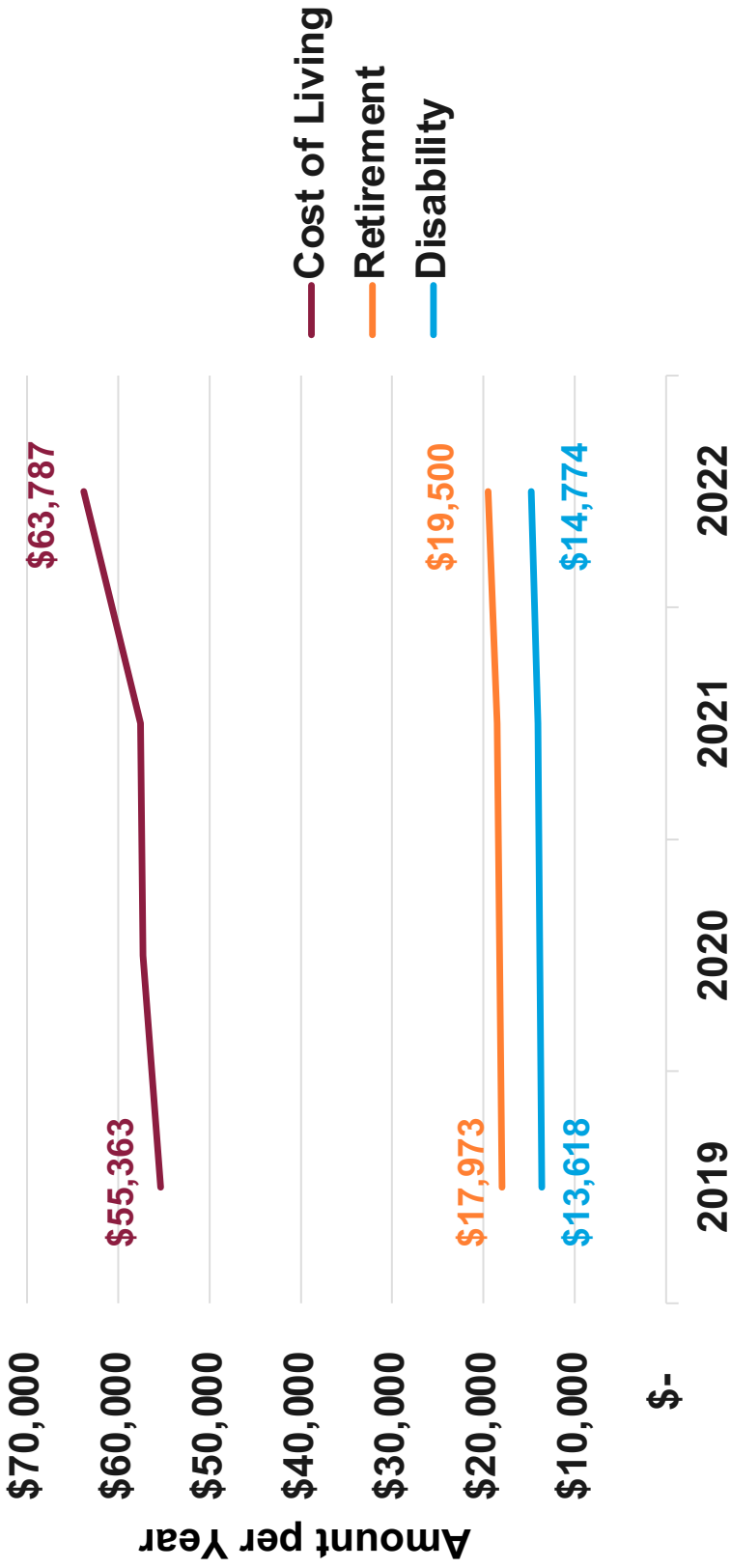
73.0 – 94.7 °F = Range of participant averages

81.9 °F = Median of each participant's average

76.4 °F = Average preferred indoor temperature



Cost of Living vs. SS Retirement or Disability



Nearly 30% of mobile home residents here have a household income of **less than \$25,000 per year.**

	Mobile Home Households	Single-family Households	All Maricopa County
Median Household INCOME	\$ 46,544	\$ 71,369	\$ 65,252
Median Housing VALUE	\$ 33,565	\$ 261,793	\$ 276,800
Median Monthly RENT	\$ 1,026	\$ 1,288	\$ 1,119

➤ **Mobile Home Households vs Single-family Households:**

- Have 65% the household income
- Live in housing valued at 13%
- Pay 80% the monthly rent amount

- **Twice as likely to forego basic household necessities like medicine or food, in order to pay their **energy bill**.**
- **11%** have trouble paying their energy bill (compared to 5% of other housing types).

40% of Indoor Heat Deaths are in Mobile Homes



Those that perish are **twice as likely** to have **no A/C unit**.

Those that have an **A/C unit** are **three** times more likely to have **no electricity** to due unpaid utilities.



Inability to afford AC creates higher **exposure** to the **shock** of heat.

Older adults are particularly **vulnerable** due to both physical condition and the likelihood of being on a fixed income.

This helps explain why we see a disproportionate number of deaths from indoor heat exposure among **older mobile home residents**.

Optimized New, Accounting for Existing Cooling Centers, 2020



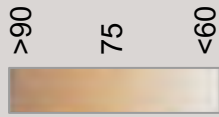
Optimized Cooling
Station Location



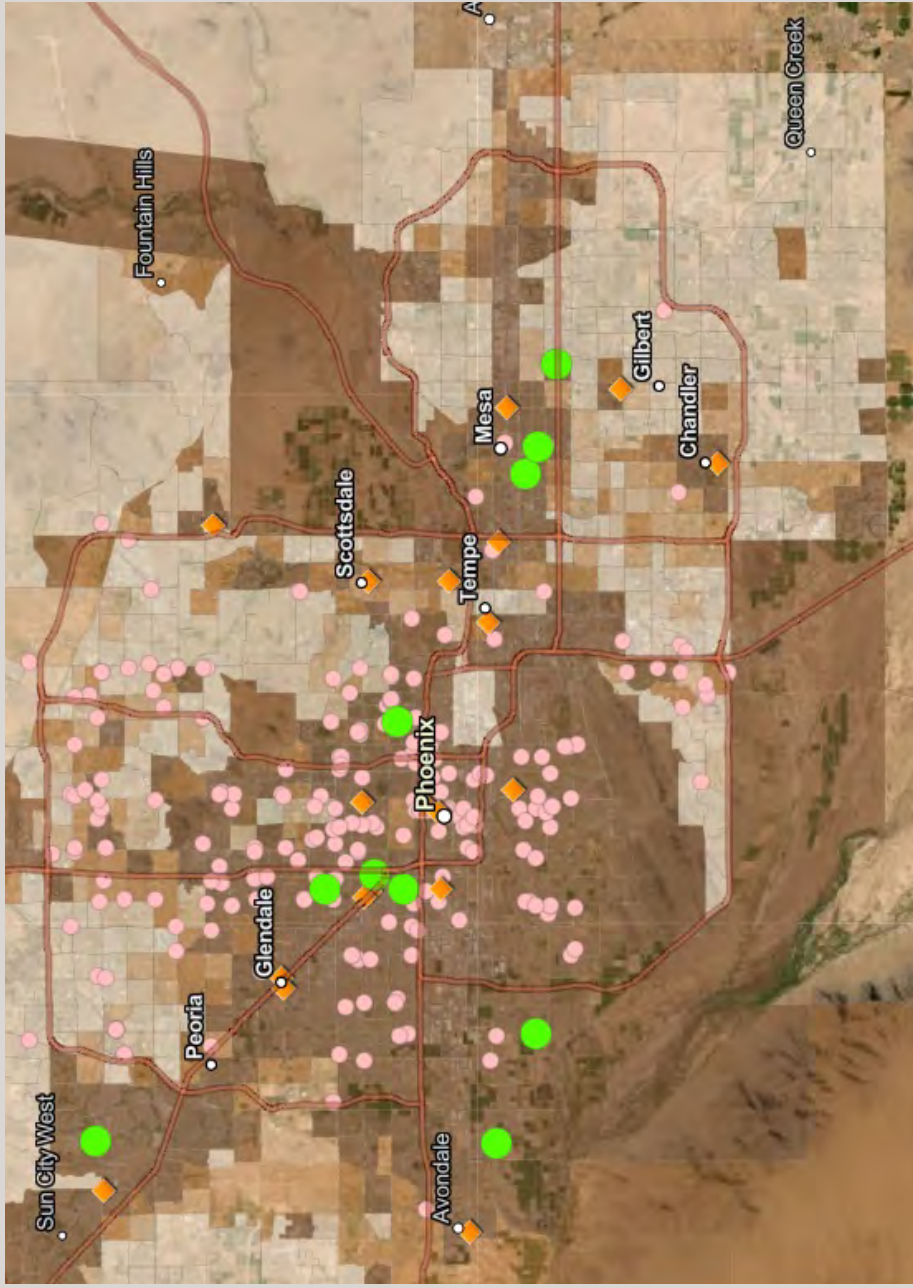
2020 Existing
Cooling Stations



2019 Heat
Refuge Centers



Social Vulnerability
Index



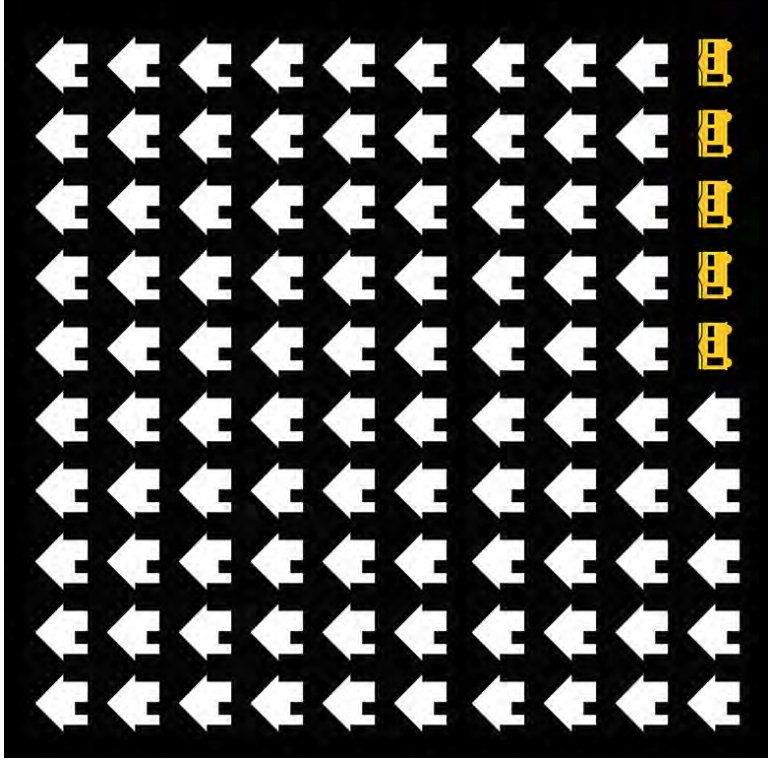
Heat Mitigation
Solutions Guide
for Mobile Homes



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for Resilience
Arizona State University



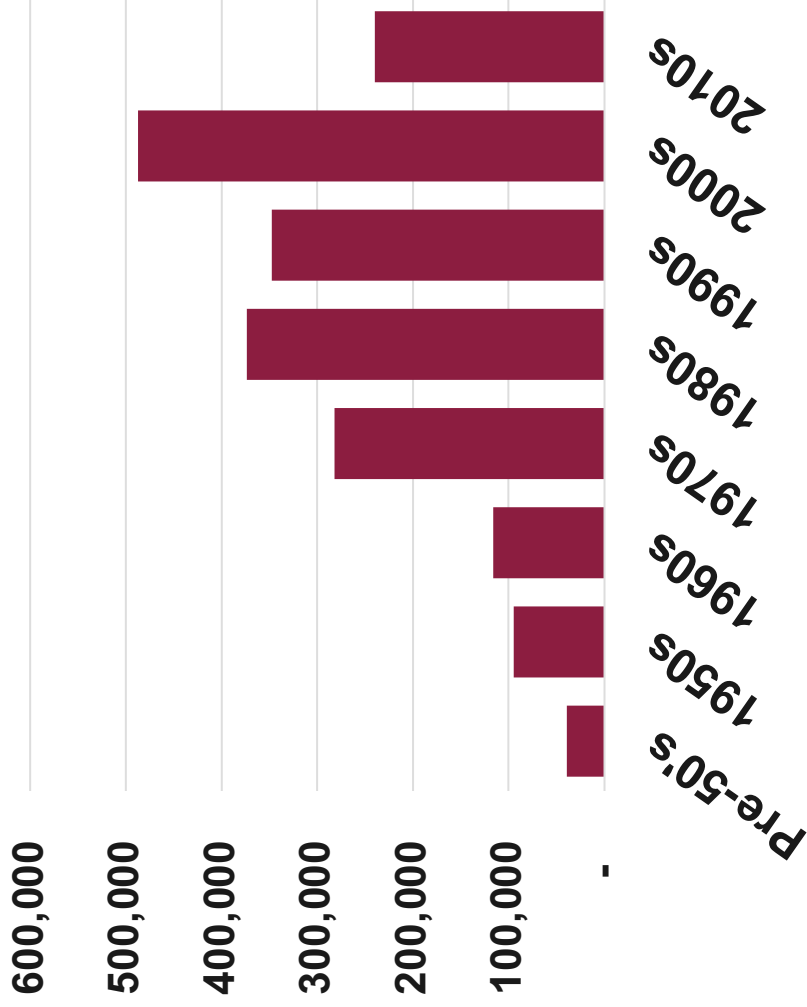
Total Housing Stock in Arizona



**EVICTION
NOTICE**

Despite mobile homes accounting for only 5% of AZ housing, the residents make up **40%** of indoor heat deaths.

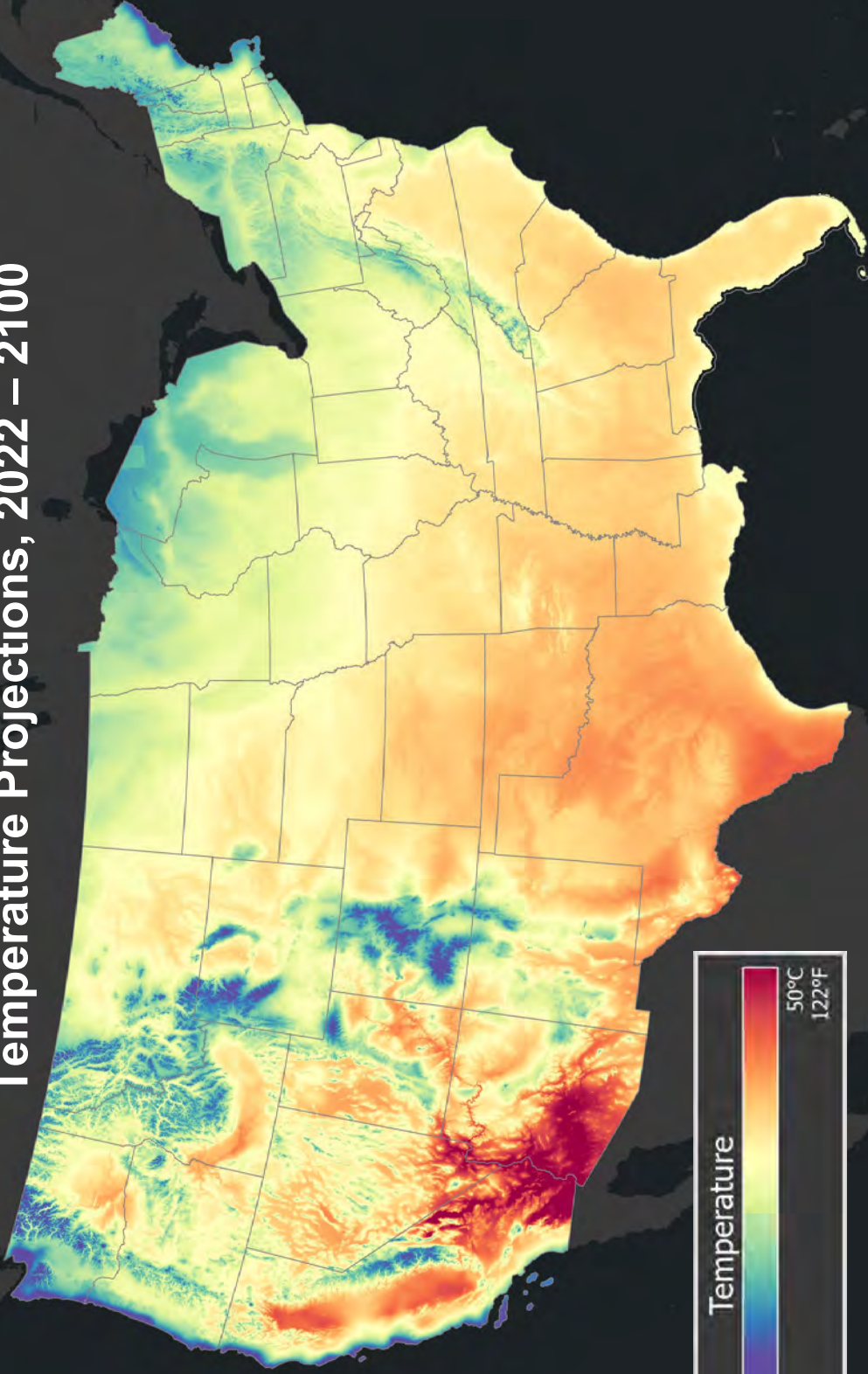
of Total Arizona Residential Units, by Decade



Homeowner vacancy and renter vacancy both at lowest point since before 2005.

Quickly absorbing housing inventory.

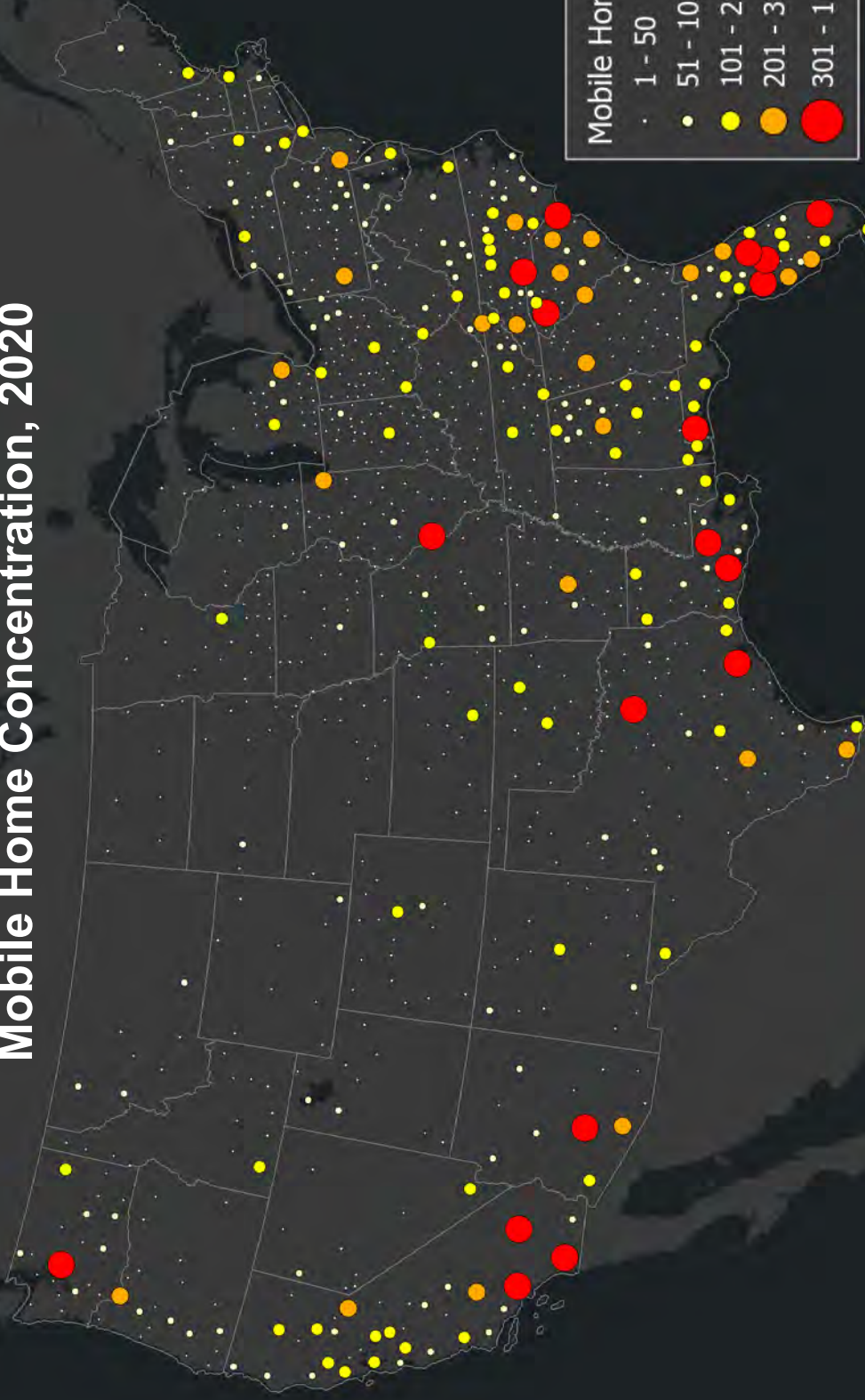
Temperature Projections, 2022 – 2100



By 2060, nearly **1 in 4 Americans will be age 65+.**

Right now that age group is only 16% of the population, yet still account for **65% of indoor heat deaths.**

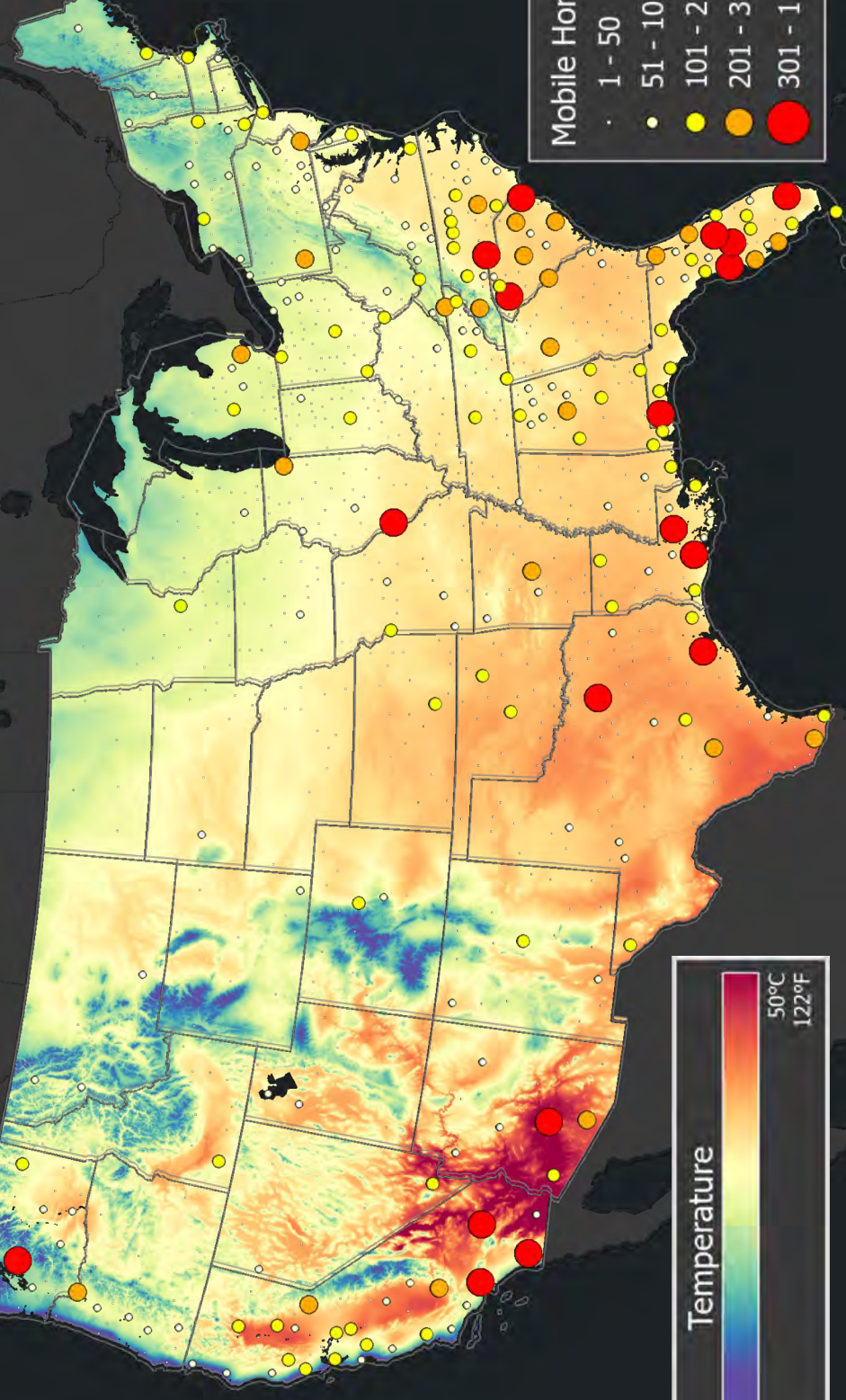
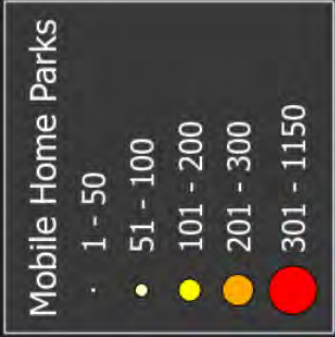
Mobile Home Concentration, 2020



Mobile Home Parks

- 1 - 50
- 51 - 100
- 101 - 200
- 201 - 300
- 301 - 1150

Mobile Homes (2020) over Temperature Projection (through 2100)



67 million older adults will be at risk of extreme heat exposure by 2060.

16 million of those are likely to be in mobile homes.



Collaborative Pilot Project on Heat Resilience Solutions for Mobile Home Residents in Metro-Phoenix Area

Executive summary

ASU Knowledge Exchange for Resilience (KER) graduate and undergraduate students engaged with local mobile home residents to develop an understanding of the complexities of heat impacts, with mentorship by ASU faculty.

The research aim is human-centered field research in the Phoenix Metropolitan Area, collaborating with mobile home residents and third-party stakeholders 3M and SkyCool. Solution-based research methods, this approach differentiates between a real-world community-engaged site and previous testing methods, such as in a highly controlled laboratory setting or a non-occupied outdoor lab. The advantages of the design will be to meet the objectives of understanding both the demand and potential for heat solutions with actual residents. As such, it is a highly exploratory experiment, being the first time that this potential material solution has engaged with real-world community members. The findings and results here should be considered preliminary, exploratory, and insightful for how to further develop research in this emerging technology opportunity for climate adaptation in the housing sector.

This is an internal written report not for publication use.

Our field research focused on how mobile home residents manage their energy usage during the summer. What are the varying utility burdens? How are mobile home residents adapting to extreme heat through cost-saving variables, DIY projects, and other adaptation means? These questions are a continuation of previous KER heat studies engaging with mobile home residents. From 2001 to 2021, the Maricopa County Public Health Department's heat mortality data reported 2,379 people died from heat-associated deaths. 40% of indoor heat-associated deaths happened indoors, specifically among mobile home residents in the Metro-Phoenix area, 23%. They are disproportionately affected by the heat given the physical structure of their homes, where we have found year to year 6 to 8 times more likelihood of mortality compared to residents in single-family homes. This focuses thus zeros in on the potential application of the film for those who are among the most vulnerable to heat.

The dataset provided to 3M and SkyCool will continue a dialogue about the potential benefits of 3M Passive Radiative Cooling Film for climate adaptation in the housing sector. We aspire for the data and results to inform potential applications in their sector. In addition, these conversations may lead to collaborating and recommending potential research questions to pursue jointly with ASU students and faculty in the future.

3M is a purpose-driven company that is committed to innovating to decarbonize industry, accelerate climate solutions, and improve our environmental footprint. They support initiatives that foster sustainable communities, including projects that protect threatened ecosystems, support local economies, enhance livelihoods, and promote science-based environmental education.

SkyCool company has been founded on the premise that cooling systems play a large role in contributing to climate change. Their aim is to improve the efficiency of all cooling systems by harnessing an untapped renewable resource: the sky. They develop and use technology to bring efficient, climate-friendly cooling to all parts of the globe.

3M Passive Radiative Cooling Film Installation

The field research included mobile home units manufactured during the 1970s, like most of the units on the site (mobile home park). The mobile home unit was inspected and selected by members from SkyCool, who favored this particular unit, ideal for the film installation. Visual observation was considered in great depth, however, the film adhesive could not stick to the mobile home roof during the first installation attempt. During our field research together with the third-party collaborators, we observed the roof conditions of mobile home units in the Metropolitan Phoenix area have varying factors of paint oxidation, structure instabilities for installation activities (age of the unit and construction methods), and the installation time frame. Due to these unexpected challenges, the installation and execution of the original research plan experienced significant delays into the heat of the summer. Weather conditions became one of the leading factors for installation as well. It is important to consider the daily extreme heat temperatures and strong windstorms during the Monsoon season as well. We observed the film adhesive could not stick in humid conditions and that there was minimal debris on the roof.

After three power washes, we observed the successful application of the film adhesive. These listed factors have contributed to the delayed process of the film installation. Discovering these factors in the field has provided our research with a great deal of revaluing the preparation of the roof to become an ideal condition to apply the film in addition to strengthening the adhesive bonding methods. This discovery is perhaps one of the most valuable among the entire research endeavor - the real-world conditions that film solutions developers much reckon with in future iterations.

The 3M Passive Radiative Cooling Film was installed onto one mobile home unit (Mhd), which was deemed to be acceptable, on August 8, 2022. One week after the film installation, the edges of the film began to lift off the roof, losing the film's bond to the roof. These observations have contributed a great deal to proposing a reworking of the application of the film and understanding the longevity of the film. The challenge in the installation of the film resulted in limited data collection, which affected further data analysis: limited collected data does not allow us to compare temperature before and after outside/inside the units.

Research methods

The quantitative research methods include two survey instruments, a pre-film installation, and a post-film installation heat starting with ten participants and ending with six participants. Losing four participants lessens a considerable amount of data to analyze. The study sample is limited as this is a preliminary exploratory project. In addition, the proposed 40 iButton and 20 Kestrel sensor data were not fully collected. The final data collection is 26 iButtons and 11 Kestrel sensor data. The provided study outcome is reflected by the reduced data. The study results will be linked to the physical measurements to provide a comprehensive report. The second part of the research efforts is to understand mobile homes' indoor and roof surface temperatures during the hottest summer months. We utilized temperature sensors and equipment, including iButton sensors, Kestrel temperature sensors, and sensor software to calibrate and program the sensors. The Kestrel sensors can collect temperature data, humidity, and dew point to document the reality of mobile home indoor temperatures throughout the day for three months. We successfully installed sensors onto six mobile home units in Mesa, AZ. We collected the sensors the week of September 11, 2022. During this time, we administered follow-up survey questions relating to changes or progressions of mobile home heat impacts.

The third part of the study is collaborating with mobile home participants, ASU KER, 3M, and SkyCool, by installing the 3M Passive Radiative Cooling Film. This process unfolded the complexities of the film installation in the Metro Phoenix region. In addition, we observed the capacity of the product. One participant received the 3M Passive Radiative Cooling Film on August 18, 2022.

Results

Survey summary

Most of the participants lived in a single-wide mobile home trailer; however, the exterior facade of the units appeared doublewide, considering the built-on awning on either side of the mobile home unit. These awning structures varied in size and style most of the spaces seemed to be used as outdoor living spaces where the participants would socialize, smoke, garden, and store additional items. The majority of the participants, 70%, acknowledged their mobile home unit was manufactured during the 1970s. 10% of the participants acknowledged their mobile home unit was manufactured in the year 2007. Half of the participants have metal roofing (e.g., steel, aluminum, zinc, copper), and only 10% have asphalt shingles. Most of the participants expressed interest in trying cooling solutions for their mobile homes: 50% are interested in trying cooling film applied to the home rooftop to reduce temperature; 20% - shade trees; 10% - high-efficiency air conditioning units; 10% - solar panels to reduce the cost of electricity; 10% - weatherization to improve the insulation of my home.

Temperature analysis

Our research team collected 22 iButton sensors and four sensors per mobile home unit. The 22 iButton data are from the Mesa mobile home parks.

Mobile Home Unit Individual Surface Temperature Analysis

R Studio Software was used to perform T-test, a statistical analysis comparing the average mean surface temperatures of indoor and outdoor surface data of each mobile home. The t-test results show surface temperature differences between the ceiling and roof of each mobile home have significant differences. The participating mobile home residents owned varying units located in varying locations in Mesa, AZ. Our observations of each mobile home unit displayed different construction, location, and geospatial impacts, including insulation, additive modifications, varying air conditioning units, vegetation, and orientation to the sun. Proposing additional studies to understand the leading impacts of these variables is key for further testing and application of the 3M Passive Radiative Cooling Film.

Mhd is the only mobile home unit with 3M Passive Radiative Cooling Film installed onto the roof. iButton sensors were placed on the roof to capture surface temperatures. Mhd sensors without the 3M Passive Radiative Cooling Film average mean roof surface temperature logged at 77.82°F, and the average mean ceiling surface temperature is 77.79°F. The roof surface temperature is .03°F cooler than the indoor ceiling surface temperature. The p-value for the average surface temperature is .9255, indicating there is no significant difference between the ceiling and roof surface temperatures.

Mhd sensors covered with 3M Passive Radiative Cooling Film average mean roof surface temperature is 78.48°F, and the average mean ceiling surface temperature is 77.79°F. The roof surface temperature is 1.31°F cooler than the indoor ceiling surface temperature. The p-value for the average surface temperature is .000139, indicating there is a significant difference between the ceiling and roof surface temperatures.

Kestrel Sensor Data

A total of 20 Kestrel sensors were deployed in the field, however, 11 Kestrel sensors were collected and calibrated. Most of the data are not viable for building envelope (indoor only) temperature data analysis due to the limited data acquisition. The data has been shared with third-party members, including 3M and SkyCool.



Suggestions

The product needs further testing in a more controlled, measured environment to confirm if it can lessen heat impacts for residents in mobile homes, such as in a field laboratory of a typical unit that is unoccupied. This testing should also include more detailed development about the adhesion properties of the film so that the significant challenges related to the application might be addressed prior to further testing with actual residents. Nevertheless, the real-world participation of mobile home residents helped the researchers to discover the extent of these installation challenges, even though they hampered sufficient data collection that would have been more likely to provide more conclusive results about the film itself.

We also recommend that further testing of the material should be performed with much more extensive sensor placement and monitorization of the data logging. It is recommended to establish a universal inventory of equipment, field/lab tools, and supplies ahead of scheduled fieldwork to prepare for any programming needs and/or delayed challenges, including unexpected results.

The research team includes stakeholders from ASU KER, ASU SGSUP graduate students, 3M, Skycool, and AAMHO. The research team brought in additional expertise to assist with obtaining the most insight from the data possible. Analysis from a collaborative professor at ASU School of Geographical Science and Urban Planning (SGSUP) concurs that due to the numerous challenges faced in the installation, not having enough data, and the fact that a thermostat was used to help control the indoor environment, this pilot is unable to assess the impact of the film itself. Nevertheless, this does not take away from the important messages around observing the in-home temperatures, experiences, room differentials, and roof temps, and relating these exposures to the surveys. As an experimental pilot, the research team emphasizes the importance of this work that aims to engage new cooling technologies for the most vulnerable in society.