Flood and Fire in the American West:
Understanding Climate-Driven Disaster Displacement and the 2018 Camp Fire

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ABSTRACT

Flood and Fire in the American West:
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(Under the guidance of Susan Handy, Nicholas Pinter, and Noli Brazil)

This dissertation work studies the effects of climate-driven flood and wildfire events throughout the American West, with a particular focus on the 2018 Camp Fire in Paradise, California. It brings together an interdisciplinary literature primarily from the fields of hazards geography, economics, planning, and environmental management in order to better understand the economic and social factors associated with recovery from climate-driven disasters. The flood component of this work draws on established theories around price discounting and flood awareness and tests them empirically across three case study counties in the United States. The fire component of this dissertation uses household-level consumer data to map population displacement in the wake of a major wildfire disaster. It also contributes by sharing the first comprehensive survey of wildfire survivors to better understand relocation desires and preferences, adding to a disaster displacement literature that has up to now neglected the category of wildfire hazards.

Findings suggest that in regard to flooding, real-estate markets continue to behave different across contexts based on the perception of the flood event as expected or a "freak event." In the context of wildfire displacement and particularly the case of the 2018 wildfire, the disaster caused a diaspora of thousands of households to relocate across the United States. Social factors were found to be correlated with relocation and relocation distance, with older and wealthier households relocating farther from the fire footprint. Survey findings from this population revealed that above 40% of displaced residents would not prefer to return to the fire-affected area even under "ideal circumstances," and that measures of place attachment and risk perception

supplement social factors as predictive of relocation distance. Taken together, analysis of these wildfire survivors suggests that local and regional planners should think regionally about post-disaster housing and recovery needs. It also spotlights the role that housing affordability plays in hazard vulnerability in California, where the populations that inhabit wildlands tend to be highly socially stratified between those who choose to live in exurban forested environments as a preference, versus those marginalized to these areas by virtue of housing affordability. Future research should continue to focus on the experiences of climate-driven disaster survivors, and interrogate the root causes of vulnerability these hazards.

Acknowledgements and Dedication

This work and my entire academic journey would not have been possible without a myriad of help and inspiration along every step of the journey. I want to start with Justin and Kelsey, whose bravery in the face of the fire continues to inspire me, and whose diverging choices about where to rebuild directed many of the research questions in my last chapter. I also want to acknowledge all my friends and family who lived through the fire and rebuilt their lives after losing everything; whether that's back on the Ridge like Ann and Mike, down in Chico like Morgan, or hundreds of miles away like Mari in Portland. Your experiences, and your willingness to share them, are the most important part of this dissertation. You are the real lives behind each data point in this work, and it has been an absolute honor to help share your stories.

I also want to acknowledge the continuing support and lifelong friendships forged at Chico State, the place where I first found my academic community and learned that I loved to learn. I would not be on this course if not for the opportunities Jacque inspired me to pursue, the guidance LaDona shared at crucial inflection points, and the collaboration with Nori that made me consider teaching as a full-time career. I would not have been able to complete this work without Anita's guidance on regression techniques, Peter's willingness to share his methods, or Eugenie's unwavering friendship and mentorship. The selfless dedication to learning and teaching embodied by my friends at Chico State continues to serve as the inspiration for my career.

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research questions shifted into the hazards realm. Nicholas has been a gracious mentor, the best editor I could ever ask for, and a supervisor whose high expectations inspire me to be the researcher he thinks I can be. Noli is the educator I want to be; a quantitative methods expert who enables his students to quickly grasp the tools they need – and whose modelling advice runs through these chapters. Beyond my committee, I also want to thank Kallee for being the best lab partner anyone could ask for, for breathing new life into research collaborations, and for her unwavering friendship and support, and of course Carrie, for keeping this program running, for her indispensable wisdom, and her kindness when I invariable file paperwork incorrectly.

I also owe so much of this work - along with my mental health through these past six years - to Mitch, my research partner and more importantly best friend from our very first day at Davis. Mitch and Holly are the found family I never knew I needed. I owe a huge thanks to Mitch, Holly, and the rest of our community at Aggie Gardens for fostering a sense of support, appreciation, and camaraderie unlike any other community I've been a part of.

Finally, I'd like to dedicate this work to all those who face disaster in their lifetimes, particularly those who, like my family, lived through the 2018 Camp Fire. It is my hope that this work not only tells an important part of this community's ongoing story, but also that its lessons might be useful in planning for a future in which California's rural communities continue to face existential threats.

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CHAPTER 1: Introduction

This dissertation investigates the phenomena of climate migration and climate gentrification by examining how flood and fire has shaped real-estate values, population distributions, and residential preferences using empirical evidence from case studies throughout the American West. Three standalone analyses advance different prongs of this work: first, Chapter 2 examines the impact of fluvial flooding on real-estate markets across three counties. Next, Chapter 3 details the displacement that resulted from the 2018 Camp Fire, the most destructive wildfire in California history. Lastly, Chapter 4 explores long-term displacement and residential preferences among the survivors of this disaster, focusing primarily on potential drivers of their willingness to return to their community. Together, these works add to a growing body of quantitative evidence about how climate-driven hazards have shaped and continue to shape populations in the United States. Survey findings in the last project provide novel insights into how beliefs and "blame" for disaster may influence one's willingness to return to a hazardous area – and therefore, the distribution of vulnerable populations in the future.

The United States is exposed to a wide range of destructive natural hazards; with hurricanes, earthquakes, floods, and wildfires among the many risks that come with the physical environments in which we have settled. With changing atmospheric conditions caused by global climate change, these risks become amplified in many regions, particularly from flood and fire. Climate-driven extreme weather events are estimated to cause $143 billion in damages worldwide beyond damages would occur in a pre-industrial climate (Newman & Noy, 2023). Portions of the United States including the Gulf Coast and the western states including California have seen disproportionate increases in climate-driven damages over the past twenty years,

primarily from destructive hurricanes and wildfires, respectively (Diaz & Moore, 2017; Summers et al., 2022). These climate-driven events not only expose millions to harm and property loss; they also threaten to overwhelm financial recovery mechanisms both private (Moore, 2024) and public (Kousky et al., 2021).

While the chief climate-driven hazard threats in many parts of the world are sea level rise and intensified tropical storms, California and the American West are becoming increasingly vulnerable to threats that have received relatively less attention until recent years: climate-driven inland fluvial flooding and climate-driven wildfires. It may seem counterintuitive that flood risk might increase alongside the other specter of climate change in the West: drought. However, global warming is expected not only to increase the variability of precipitation in California (Swain et al., 2018), but produce warmer precipitation at higher altitudes such that mountain runoff is increased in watersheds that typically receive much of their precipitation as winter snowfall (Huang & Swain, 2022). While the total amount of precipitation throughout the year might stay the same or even decrease, storms are likely to be warmer and more intense when they do occur, leading to higher peak flows that may overwhelm climate-ignorant infrastructure built for an outdated flow regime. The effect of this atmospheric change on wildfire risk is more straightforward to conceptualize: warmer temperatures and associated lower humidities dry out vegetation at a faster rate, creating a lengthened fire season that widens the window within which a small blaze can become a destructive wildfire (Goss et al., 2020). This has already been the primary mechanism behind an observed fivefold increase in annual acres burned in California when comparing the 1970s to the 2010s (Williams et al., 2019), with a growing number of these destructive wildfires taking place in late autumn when forests are at their driest (Keeley & Syphard, 2021).

Of course, biophysical conditions are only partly to blame for natural disasters; a physical event only becomes a "disaster" when people and their built environments are threatened. Unfortunately, communities in California and other western states have largely doubled down on development in hazardous areas, particularly with respect to wildfire. More than 12 million new homes were built in America's wildland-urban interface areas during the 1990s and 2010s (Radeloff et al., 2018). This rapid rate of development had an effect of not only embedding more residents within already flammable forests, but also increased ignition probabilities and thus the risk of destructive wildfires in these areas (Syphard et al., 2019). In California, few policies exist to curb development in these areas; communities focus rather on evacuation plans, building codes, and individual property mitigation to achieve a measure of wildfire protection (Mockrin et al., 2020; Syphard et al., 2013). In fact, on a statewide level, the enormous risk posed by wildfires has been described as having "not influenced California's land use planning or growth patterns in any meaningful way" (Fulton and Shigley 2018, pp. 411). Building in fluvial flood zones has been somewhat better tempered by state guidance that largely forbids development in floodplains, but that guidance continues to rely on climate-agnostic floodplain delineations (OPR, 2017). More troublingly, infrastructure upgrades in some areas have spurred developments in lands now deemed "out of the floodplain" (Pinter, 2016), and the federal government's insurance mechanism continues to provide unsustainable subsidies to floodplain development (Kousky et al., 2021).

Lastly, the compounding effects of development policies and climate change may be changing the landscape of social vulnerability to these flood and fire hazards in California. Ever since the key insight that hazard vulnerability has a measurable *social* dimension in addition to the physical dimension (Cutter, 1996), many researchers have sought to better understand social

vulnerability to hazards and how it may change over time. In one framing of vulnerability, populations most exposed to hazards tend to fall into one of two groups: either those who have the resources (community, social, financial) necessary to allow them to choose to live in these areas, or those who are marginalized to these areas by virtue of poverty or land scarcity (White et al., 2001). Both groups live in the flood and fire-prone landscapes of Calfifornia and the American West, and both are worthy of study. However, this work is especially interested in those in the second group – those that may prefer to live in lower-hazard areas if they could afford it. As climate change continues to reshuffle the physical determinants of flood and fire hazards, and decades of misguided land management begin to come home to roost, perceptions of these hazard risks may be leading to novel changes in housing affordability and residential preferences. The value of communities perceived as "safe" from climate-driven hazards – by virtue of either a favorable physical geography or presence of the wealth and resources adequate to pursue adaptation measures – may increase along with public awareness of the true scope of climate-driven risks. These changes, which have been observed in the context of sea-level rise and dubbed "climate gentrification" (Keenan et al., 2018), remain understudied in the fields of inland flood and wildfire risk. This dissertation aims to alleviate that gap on both fronts by examining the real estate impacts inland flooding in three counties throughout the American West, and understanding the population diaspora and preferences of survivors of the 2018 Camp Fire, the most destructive in California history.

Study Sites and Positionality

Fluvial Flooding in the American West

In the American West, threats of fluvial flooding predominate over coastal flooding. The relatively younger and rockier geology of the Pacific coast means that the threat of coastal flooding, and any incremental climate-driven increase in such flooding due to sea level rise, is relatively confined to a few major coastal hazard zones including low-lying areas around San Francisco Bay. Fluvial flooding, on the other hand, threatens many inland communities, including areas near river confluences like Sacramento, where the Great Flood of 1862 submerged much of the city for weeks under climate conditions that could happen again today (Jones, 2018). The incremental effects of climate change on the already variable precipitation regimes and rugged topography of much of the American West can be difficult to capture. Recent climate-informed flood modelling has suggested that FEMA's current floodplain mapping – the primary source of flood risk information for everyday Americans – severely underestimates flood risk (Wing et al., 2017), with many western states including California projected to see the total value of assets in the 100-year floodplain doubling by 2100 under a scenario with unmitigated greenhouse gas emissions (Wing et al., 2018).

Foundational work in this region (Tobin & Montz, 1988, 1997) has shown how perceptions of fluvial flood hazard can shape the value of housing in floodplain communities, and thus the vulnerability of residents experiencing successive disaster events. Their work examined Olivehurst, California, a levee-protected floodplain community at the confluence of the Yuba and Feather rivers in northern California. After an initial catastrophic flood event caused by a levee break, real estate values in the town recovered fairly quickly; the levee break being

perceived as a “freak incident” that was unlikely to happen again (Tobin & Montz, 1988). However, after a subsequent flood disaster caused by another levee break less than ten years later, real estate values dropped and failed to recover. Flooding was now seen as a given in the community and priced into the real estate market (Atreya et al., 2013; Tobin & Montz, 1997). Under a climate-driven flow regime of even greater concentrated precipitation events, communities like Olivehurst may expect to see permanent decreases in real estate values after subsequent flood events (Pryce et al., 2011) such that the additional risk of flooding brought by climate change is capitalized into the local market. Similar communities throughout the American West that have experienced climate-driven flood events can continue to be monitored for how the “information update” of a flood event affects the price of real estate in known floodplains (Miller & Pinter, 2022).

Paradise, California aka “the Ridge”

On November 8, 2018, the most destructive wildfire in California history struck Paradise, California, destroying over 14,000 structures, killing 85 residents, and displacing approximately 40,000 people (Wallingford, 2018). The so-called “Camp Fire” burned on for weeks, but Paradise and nearby communities including Magalia (referred to collectively in local parlance as “The Ridge” were largely destroyed during the fire’s first few hours. The first few hours of the fire were marked by the blaze’s rapid advance and remarkable structure-to-structure spread, which triggered frenetic evacuation efforts (Smith & Wigglesworth, 2023) and a chaotic landscape of short-term displacement to the unaffected homes of friends and family or to several nearby shelters (Grajdura & Niemeier, 2022). In the year after the fire, a clearer picture of the fire’s displacement began to emerge. With approximately 85 percent of the town’s housing stock

destroyed, Paradise's population sat at approximately 4,000 people in 2019 (compared to a pre-fire 26,000 people), with many thousands of residents displaced to nearby communities or relocated distant and/or out of state (Chase & Hansen, 2021).

Now, more than five years after the fire and amidst a slow but steady rebuilding process, many questions remain unanswered. First, what does the long-term displacement landscape look like for survivors of this wildfire? How many residents have returned, and how have more vulnerable residents fared relative to those who might have more resources and social ties? Second, how are these wildfire survivors now approaching their preferences about where to live? How many displaced residents still yearn to return, if only for the right opportunity, settlement payment, or drop in construction prices? Conversely, how many displaced residents would not prefer to return, even under ideal conditions? How do notions of place attachment, residential preferences, and even risk perception and climate awareness factor into these decisions?

From a physical standpoint, Paradise and the Ridge might be considered a textbook example of a wildland-urban interface (or intermix) community – defined as generally low-density urbanized environment built into a wildland forest ecosystem (Radeloff et al., 2005). Recent work assessing the social vulnerability of those living in these fire-prone wildland areas suggests that California forest communities are less likely to be home to those in socially vulnerable categories as when compared to forests elsewhere in the United States (Schumann et al., 2024). One imagines the wealthy, often coastal communities that have been affected by previous California wildfires, including the Oakland Hills, Montecito, and Malibu. Mike Davis (1995; 1998) and others have appropriately characterized these places as unsustainable "fire suburbs" which are inherently risky and benefit from public subsidy in the form of regional firefighting and forest management (Rodrigue, 1993). But how does Paradise relate to these communities? As a lower-middle

income community situated a more rural and economically impoverished corner of the state, Paradise is a fascinating case study within which to explore themes of vulnerability, affordability, and risk perception as they relate both to long-term displacement, and willingness to return or rebuild again in a fire-prone forest.

Researcher Positionality

Natural hazards are not merely an academic construct for me as a researcher, they are part of my lived experience. One of my earliest childhood memories from growing up in a small agricultural community in the Sacramento Valley is evacuating from the threat of Sacramento River flooding driven by El-Niño-fueled storms at the behest of the National Guard during the winter storms of 1997. As an older child, my family's search for affordable housing that would allow us to move out from my grandparents' house in the Sacramento Valley brought us "up the hill" to Paradise, where we moved in 1998. Paradise quickly became our new home, and while I left for college after graduating from Paradise High School in 2008, my mom, brother, and sister stayed home, where they lived until November 8, 2018. My mom's house, along with the homes of almost all of my friends and their families, burned to the ground that morning in the Camp Fire. While my mom had been away at work when the fire started, my sister, 18 at the time and a newly licensed driver, was responsible for saving both herself, my brother whose special needs limit his mobility, and most of our pets as the fire rapidly advanced through the neighborhood. Thus, while I strive in this work to connect the experiences of those who lived through the Camp Fire to the broader academic literature and to national and global issues including climate migration, this event will always be a tragedy that struck my friends and family first, and an object of academic study second.

My closeness to this work had undoubtedly brought about some researcher biases, but also perhaps some advantages as well. It is often difficult for me to untangle my own mixed feelings about Paradise from the lived experiences of all those who called it home. The Ridge was home to many great people – but it could also be home, unfortunately, to conspicuous bigotry and homophobia, a primary reason for my own out-migration from the community as an adult. I believe that the community's conservatism and cultural homogeneity served as important drivers of many residents' decisions to settle or retire in the community as opposed to in other nearby communities. Some wildfire survivors we spoke to during the survey process even espoused various fringe and antisemitic conspiracy theories behind the fire and/or how it started. Nevertheless, I know that these views do not represent the community as a whole, and that regardless, my personal beliefs should not interfere with data collection. My research did not directly broach these topics, but I hope to continue interrogating these relationships between political ideology and residential preferences that might relate to hazard risk. On a more positive note, I suspect that my identity as a local helped greatly in the data collection process described in my third paper (Chapter 4). I worked collaboratively with fellow UC Davis PhD student Mitchell Snyder, who is also from the region and has family connections to Paradise, and I believe our identities, approachability, and familiarity with the communities were major assets in data collection. I also feel emboldened, as a local and as someone whose family home was lost in the fire, to take a critical look toward the town, its inhabitants, and local governments in a way that outside researchers might not be willing or able to do. While my relationship with Paradise remains complicated, it has been the privilege of a lifetime to dedicate these years of my professional life to helping tell the story of the town and its inhabitants. I am motivated not just professionally but also personally to help foster more hazard resilient relationship between

Californians and their physical environments, and I believe that accurately capturing the impacts of the Camp Fire to Paradise and its former residents is an important way to further that agenda.

Statement of Organization

This dissertation is organized as follows: this first chapter has laid out the background literature and my motivations for doing this work. The following three chapters (2 through 4) each present a self-contained project in the style of an academic journal article, each with their own internal introduction, methods, analysis, and discussion. Lastly, Chapter 5 presents an overall conclusion of findings from across these three works and lays out an agenda for future research.

For example, the first project (described in Chapter 2) asks the question: *how did real estate markets respond to flood events in three U.S. counties*? This work employs a difference-in-differences hedonic regression approach informed by Bin and Landy (2013) and Zhang (2016) on real estate sales data obtained from Zillow. Data was obtained from three mid-size metro areas: Benton County, Oregon (Corvallis), Boulder County, Colorado (Boulder/Longmont), and Cass County, North Dakota (Fargo). Regression results revealed significant price discounting in floodplain areas for two of the three communities: Corvallis and Boulder. However, while price discounting in Corvallis showed signs of permanence, prices in Boulder recovered to pre-flood levels within two years. This findings suggests that residents in Boulder may have perceived the flood event as a "freak occurrence" while residents of Corvallis may have understood the flood event as part of a "new normal", following the diverging price recovery paths posited by Tobin and Montz (1997).

The next two projects, contained in chapters 3 and 4, both examine the population displacement that followed the 2018 Camp Fire disaster in northern California. Chapter 3, driven by household relocation data, asks the question *where did households move after the fire?* Secondarily, it seeks to understand *how do vulnerability markers such as age, income, and home value affect*

relocation? This chapter presents an analysis of over 8,000 households who lived within the fire footprint in 2018 for which current address information was available, using methods previously employed in understanding the population dispersion from Hurricane Maria (DeWaard et al., 2020) and the initial dispersion from this very fire (Chase & Hansen, 2021). It also examined household demographic factors like age and income which have been found to be predictive of long-term relocation in other hazard contexts (Paul et al., 2024). Most notably, household age was observed to have the opposite effect of relocation propensity here as compared with other disaster events like Hurricane Katrina (Groen & Polivka, 2010; Hu et al., 2019; Landry et al., 2007). Pre-fire home value was also found to be a significant predictor of a household's likelihood of relocating back into another fire zone, suggesting that many displaced populations are vulnerable to losing their homes in wildfires once again.

The final standalone project, presented in Chapter 4, picks up where Chapter 3 leaves off by hearing from fire survivors themselves about their relocation experiences. This was accomplished via a survey of the more than 8,000 households for which address data was obtained in the previous chapter, supplemented by additional social media and in-person recruiting. Ultimately, survey data gathered from over 700 households helps us answer key research questions, including *how many long-term displaced residents would still consider moving back to Paradise under ideal circumstances?* and also *what factors are related to this preference?* This data also allows additional context that helps shed light on the second research question in the previous chapter: *how has place attachment, risk appetite, and residential preference affected relocation [in addition to vulnerability markers explored in the previous chapter]?* This chapter found that over 40% of displaced residents would not desire to move back to Paradise even under "ideal circumstances," and that measures of place attachment and

household demographics are predictive of this preference. This rich survey data contributes significantly to understanding the 2018 Camp Fire as a singular disaster event, and suggests that future recovery efforts may be improved by focusing as much on helping disaster survivors rebuild elsewhere as they do on emphasizing a return to the affected community.

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CHAPTER 2: Flood Risk and Residential Real-Estate Prices: Evidence from Three US Counties

Abstract

This paper analyzes residential property transactions* to better understand the impact of urban flooding events and property distributions on the floodplain on real-estate markets. We studied patterns before and after major fluvial flooding events in three counties that experienced such events between 2009 and 2013: Benton County, Oregon; Boulder County, Colorado; and Cass County, North Dakota. We tested for the presence and distribution of price discounting before and following these flood events using a hedonic difference-in-difference regression model. Floodplain discounts were detected in all three counties, over the full study period, including before and after flooding. However, only Boulder County exhibited a statistically significant price discount in the wake of the flooding event at the center of our analysis, with prices falling by 6.26% in the 100-year floodplain until they rebounded after approximately 2-3 years. In Benton County, we were not able to detect a post-flood price effect, but prices throughout the study period were 9.4% lower in the 100-year floodplain compared to comparable properties outside the floodplain. Cass County experienced weaker discounting and only in the 500-year floodplain, but a large flood control project was widely discussed after the 2009 flood event, which may have prevented widespread price discounting. The Boulder County case study confirms the phenomenon of post-flood real-estate discounting and subsequent rebound, as documented by other researchers. The other two case studies, interestingly, document that such

* Data provided by Zillow through the Zillow Transaction and Assessment Dataset (ZTRAX). More information on accessing the data can be found at http://www.zillow.com/ztrax. The results and opinions are those of the author(s) and do not reflect the position of Zillow Group.

discounting is not universal. We suggest that the difference seems to be explained by differing levels of pre-flood local flood-risk awareness, along with the magnitude of the triggering flood event. The new availability of nationwide real-estate data allows for new and more detailed assessment of these important distinctions.

Introduction

The relationship between perceived hazard risk and real-estate prices has long been of interest to economic, policy, and planning researchers (Tobin and Montz, 1988; Kousky, 2010). This paper uses property transaction data provided by Zillow to test established theories of residential price declines and eventual rebounds following locally significant flooding events. This work makes use of a nationwide dataset to extend similar statistical tests to multiple flood-affected counties which have thus far lacked study. Most prior research has used data from local county/parish assessor's offices or multiple listings services, so that a secondary objective here is to evaluate the use the Zillow "ZTRAX" dataset to reproduce such studies in disparate geographies across the United States.

While it may seem logical for prices to drop following a natural disaster such as a flood, such price discounting indicates a lack of adequate risk awareness among the real-estate purchasing public prior to the event. Where prospective homebuyers have perfect information about hazard risk and behave rationally, natural disasters should in theory have no impact on real-estate values, as such hazards should have already been capitalized into market prices (Pryce et al., 2010). Thus, the presence and durability of post-hazard price discounting can be interpreted as an indicator of incomplete awareness of a given natural hazard.

Tobin and Montz (1988) quantified the impacts of catastrophic flooding on the Yuba River in 1986 on property values in the communities of Linda and Olivehurst, California in what is now considered a foundational analysis of post-flood price discounting. They posited a model of a steep drop in prices immediately following an event, followed by a gradual return to pre-flood prices, fueled by public perception that such catastrophic floods are 'freak' or 'rare' events. They suggested that the longer the return interval for a given hazard, the less that hazard is capitalized into the housing market, leading to steeper property price drops when the 'shock' of the flood event takes place (Tobin and Montz, 1988). After another severe flood inundated the same communities during California's El Niño winter of 1996, this second flood provided an opportunity to further test the model proposed in their earlier paper. Tobin and Montz found that the 10-35% price drops experienced immediately after the first (1986) flood were followed by a period of price recovery that lasted 4-6 years. Flood risk had been virtually factored out of the market by the time of the second (1996) catastrophic flood (Tobin and Montz, 1997).

Other researchers have estimated this price discounting following floods and other natural disasters, finding a wide range of discount intensities and durations. Lamond et al. (2010) used a repeat-sales method to estimate discounting following floods in small cities across northern England, finding that properties in the flood zone were discounted by up to 40% following major flood events. They suggested that home purchasers behaved in an "entirely reactive manner and evaluating risks based on recent experience rather than scientifically calculated probabilities" (Lamond et al., 2010, 350). Atreya et al. (2013) found similarly large price drops of between 28 and 47% in the 100-year floodplain that lingered for 7 to 9 years depending on model specification following flooding along the Flint River in Albany, GA caused by Tropical Storm Alberto in 1994. Not every paper on this topic has reached similar results, however. For

example, Kousky (2010) found no significant price declines floodplain in St. Louis County, Missouri following the Great Flood of 1993.

More recently, in the early 2010s, catastrophic flooding along Australia's eastern coast provided opportunities to estimate flood effects in the Brisbane and Gold Coast regions using detailed real-estate transaction data. Eves and Wilkinson (2014) observed a 20% drop in prices in the flood-affected areas 12 months after flooding of the Brisbane River in January 2011. Rajapaska et al. (2016), studying the same flood event, observed a 5% drop that lasted for more than two years. They also uncovered non-linear effects, including a tendency for shoreline and riverside properties to retain their value better than nearby properties which were not adjacent to the water but experienced the same intensity of flooding (Rajapaska et al., 2016).

In a 2011 meta-analysis, Pryce et al. (2011) characterized participants in real-estate markets as having both 'amnesia' about previous flood events and 'myopia' about the likelihood of future events, leading to under-capitalization of risk as time grows between hazard events, similar to the conclusions of earlier researchers such as Tobin and Montz. They also introduced a climate change element to risk capitalization, pointing out that in locations where the frequency and intensity of flooding is expected to increase due to climate change, property prices should *continue to decline* rather than rebound in the wake of catastrophic flooding events. In this view, the observed tendency for properties to eventually rebound to pre-flood levels indicates not only imperfect information about *current* hazard risk, but perhaps also a failure to acknowledge that climate change continues to affect flood risk.

This analysis builds on this body of literature by empirically testing for 1.) the presence of any post-flood real estate discounting and 2.) the duration of any such discounting in the wake of significant flooding events across three geographically disparate U.S. counties.

Study Area

We selected three U.S. counties in which to assess real-estate discounting and price recovery following flooding: Benton County, Oregon; Boulder County, Colorado; and Cass County, North Dakota. These counties were chosen according to several criteria, including: the timing of the flood event, the availability and completeness of real-estate transaction data both before and after the event, and the availability of floodplain delineation data from the Federal Emergency Management Agency (FEMA). Additionally, each of these counties is anchored by a mid-size urban area that lies partially within a 100-year or 500-year floodplain, ensuring a sufficient quantity of real-estate sales both within and outside of the floodplain.

Benton County, Oregon

Benton County (Figure 2.1) occupies a portion of the Willamette Valley and includes the city of Corvallis, home of Oregon State University. Corvallis and neighboring communities flank the Willamette River and small tributaries that are prone to flooding, including Dixon Creek and Mary's River. In January 2012, a winter storm caused significant flooding throughout the Pacific Northwest, with flood damage occurring along multiple rivers along the Oregon's coast and interior. Benton County was one of Oregon's most damaged areas in the event, with FEMA offering over $2.9 million in public assistance after the flood (FEMA, 2012) and an estimated $10 million of public and private damage in Benton County alone, though many damaged properties were outside the regulatory floodplain and thus did not carry flood insurance (Gillespie, 2012).

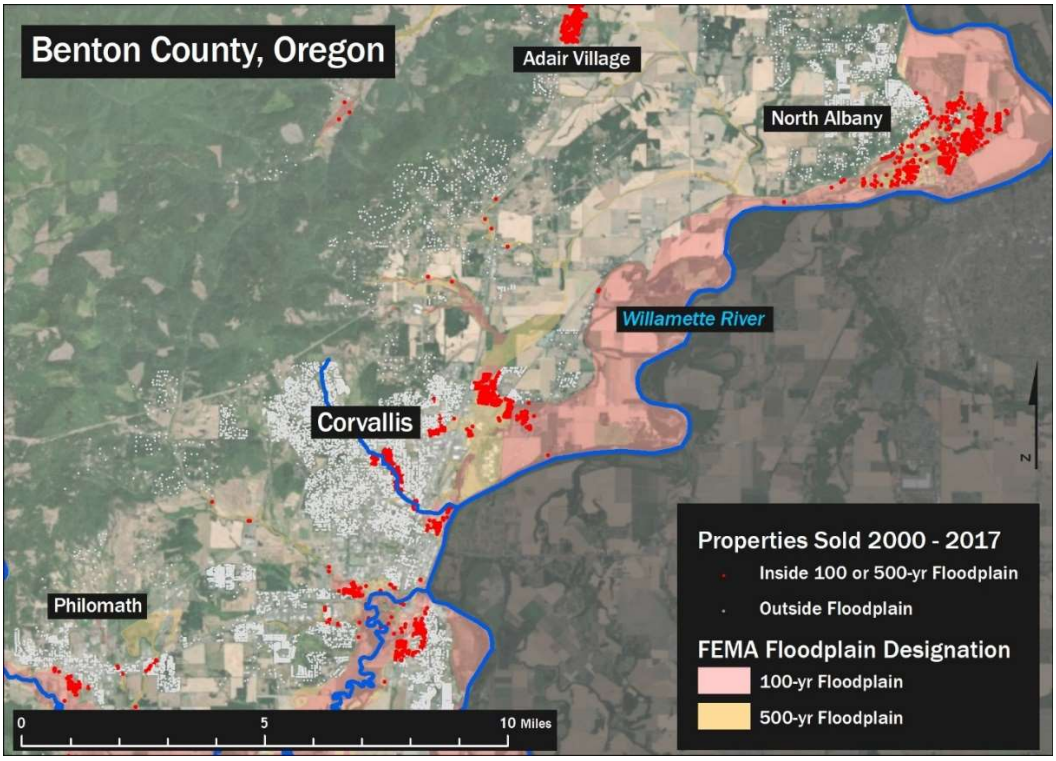

Figure 2.1. Floodplain designations and property sales in Benton County, OR

Boulder County, Colorado

Boulder County (Figure 2.2) is located approximately 50 km northwest of Denver, along Colorado's heavily urbanized Front Range. Boulder Creek, which has a catchment area covering a large portion of the Front Range foothills, runs through the City of Boulder's densely developed downtown area on its course to the South Platte River, presenting a flood hazard when precipitation occurs in the Rocky Mountain foothills. In September 2013, more than 46 cm (18 inches) of rain fell over four days along the foothills of the Front Range, leading to an event referred to as the 2013 Colorado Front Range Flood. High rainfall totals caused flash flooding along Boulder Creek. The City of Boulder spent $27.6 million on flood recovery efforts (Boulder, 2019), and FEMA contributed over $181 million in public assistance county-wide

(FEMA, 2013; FEMA, 2018). Total damages from the event (in Boulder and neighboring counties) approached $3 billion (Castellani, 2017).

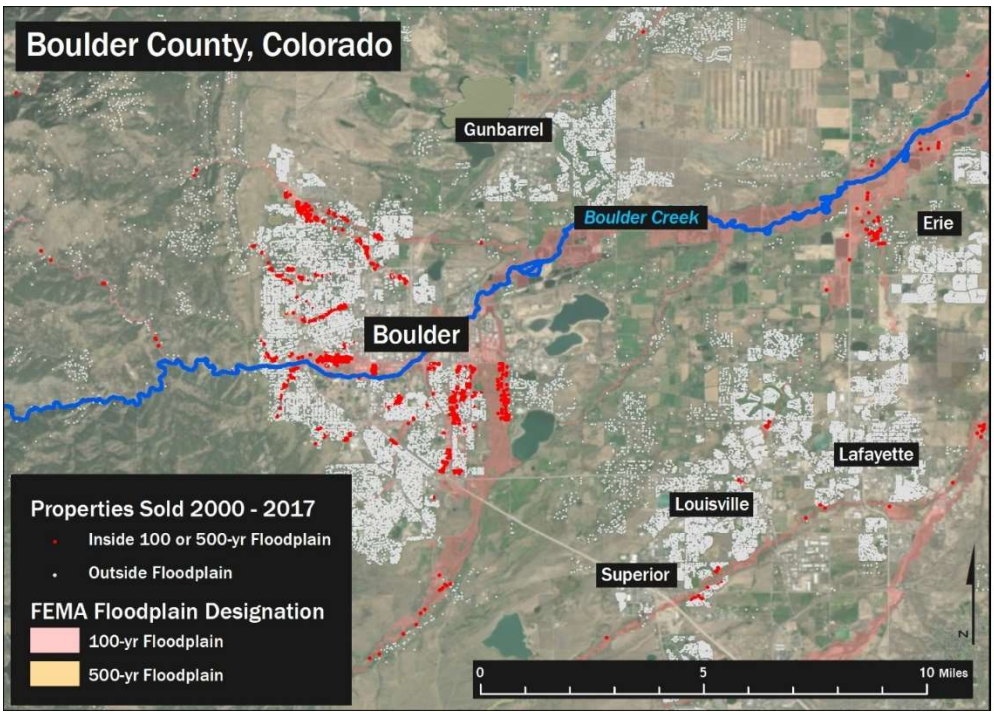

Figure 2.2. Floodplain designations and property sales in Boulder County, CO

Cass County, North Dakota

The Red River of the North runs through the Fargo-Moorhead metropolitan area, which includes Fargo and Cass County on the North Dakota side and Moorhead and other communities in Minnesota (Figure 2.3). The Red River flows north toward Lake Winnipeg, causing a special flood risk as melting snow and ice in the southern part of the watershed can encounter ice jams as they flow northward. In January 2009, rapid snowmelt coinciding with spring rainfall caused severe flooding in communities along the Red River (FEMA, 2009). Many areas of new residential development in Cass County were built in the floodplain, including large portions of Fargo located south of the downtown area. Over $150 million in disaster aid was provided to North Dakota for damages incurred during the 2009 flood (US Army Corps of Engineers, 2011). Previous research found evidence of statistically significant residential price discounting within the 100-year floodplain in the first two years following the 2009 flood in Cass County and in neighboring Clay County, Minnesota (Zhang, 2016).

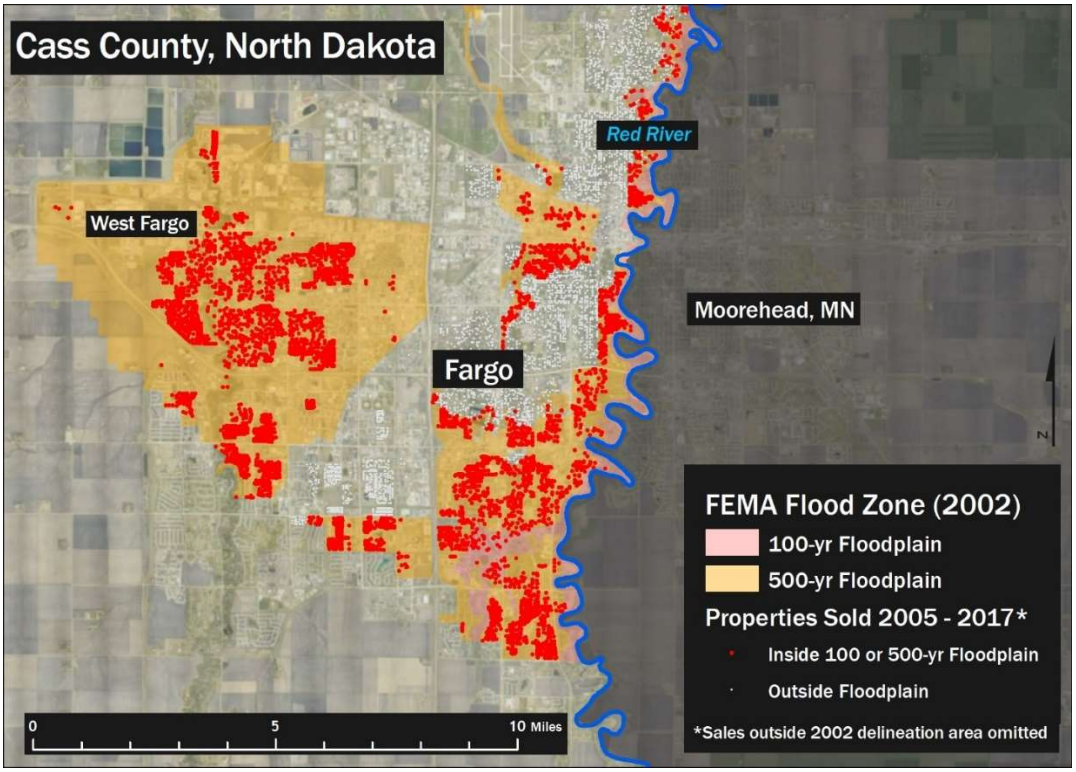

Figure 2.3. Floodplain designations and property sales in Cass County, ND

Methodology

This analysis used property transaction data from the ZTRAX assessor and transaction database provided by Zillow (2020). Data from transactions within FEMA flood zones were used to investigate the effects of presence in the floodplain after a major flood event on residential real-estate prices. We identified properties within the 100-year floodplain, where federally underwritten mortgages must carry flood insurance, as well as properties within the 100-year and the 500-year floodplain, where flood insurance is recommended rather than mandated. We constructed a panel dataset in which floodplain designation was attached to countywide residential real-estate transactions beginning at least four years prior to each county's flood event and ending at least four years after the event. Those data were then used to construct multivariate regressions with hedonic variables that may influence home sales price such as building size and

age, along with interaction terms that captured the unique characteristics of sales that occurred within the floodplain after major flood events, employing the "difference-in-differences" or DND technique. This section details the data used to construct the panel dataset, and then explains how the DND regression was used to estimate post-event pricing effects.

Input Datasets

Transaction information in the ZTRAX database varies by county, but typically includes sales prices, sales dates, loan terms, and property-specific information such as building age, square feet, and, in some jurisdictions, amenities including number of beds/baths, heating and cooling systems, and additional property characteristics. The ZTRAX database is compiled primarily using public records and assessor's office information, meaning that the quality and completeness of property characteristics vary with the reporting requirements and data infrastructure capacities of individual county-level governments (Zillow Corporation, 2020). Importantly, these transactions also include georeferencing information including street addresses and geographic coordinates. We used the latitude and longitude associated with each building participating in a transaction to geocode the data, so that it could be intersected with floodplain information from FEMA.

Through its National Flood Insurance Program (NFIP), FEMA produces the National Flood Hazard Layer (NFHL), consisting of digitized floodplain delineation information across large geographic areas (counties and states). The NFHL identifies zones deemed not-at-risk, areas in the 500- or 100-year floodplains, as well as specially designated zones (e.g., coastal-hazard "V Zone"), for example, based on specific risk or protection offered by levee structures. Detailed NFHL is not available everywhere in the US, but detailed floodplain boundaries were available

for the three case studies here. In Benton County, Oregon and Boulder County, Colorado, the digital NFHL was in effect prior to the 2011 and 2013 floods, so we use the NFHL in our analysis without alteration. However, Cass County's floodplain delineation was updated in 2015, subsequent to pressure to update the maps after the 2009 flood. In order to capture the effects of information available to homeowners at the time of the flood, we used older FIRM (Flood Insurance Rate Map) panels to establish levels of flood risk in Cass County. Hard-copy map panels from 2002 were georeferenced and digitized for the municipalities of Fargo and West Fargo, which together comprise most residential transactions in Cass County.

In addition to FEMA data, we used the spatial locations of sales transactions to calculate a Euclidian distance from the economic center of each county, and appended each property with the median household income of the corresponding Census Tract as of the 2012 American Community Survey.

It is important to note that the inundation areas for each flood event may not coincide completely with FEMA's floodplain delineations. The NFHL seeks to delimit the areas that would be inundated in a statistical 100-year flood, but every flood event differs in magnitude and in detail. Further, price impacts stemming from actual flood damage are not binary; in reality, we would expect price impacts to vary with flood depth (Wing et al., 2020), a level of granularity that is missing from this analysis.

Regression Technique

Difference-in-differences (DND) is an econometric technique that estimates the effect of an event on a "treatment group" by comparing that group to average changes across a broader control group, thus mimicking the design of a natural experiment (Card & Krueger, 1993). This technique is performed by constructing a regression on a panel dataset that includes binary variables that identify three important properties for each case in the regression: presence in the treatment group, timing after the "treatment", and an interaction term for those cases which are both in the treatment group and occurred after the treatment. If the coefficient of this interaction term is significant, then it can be concluded that the treatment had a unique effect on the treatment group – in other words, differences over time within the treatment group are statistically distinct from differences over time across the entire dataset.

In this study, the treatment groups are the residential property sales that occurred within the 100- and 500- year floodplains in each study area, and the treatments are the flood events that struck each area, as described in the introduction. To isolate these effects, each sale event must also be associated with other property qualities (known as "hedonic" price controls) such as building size and amenities; our hedonic price controls are inspired by those used by Atreya et al. (2013). The DND technique has been used to examine environmental effects on residential property values, for example by Hansen et al. (2006), who used DND to examine the effects of a pipeline rupture on properties in Bellingham, WA. Most importantly for this research project, the technique has also been used to show price discounting after flood events, including but not limited to flooding along the Mississippi and Missouri Rivers in the early 1990s (Kousky, 2010) and in Pitt County, North Carolina following floods caused by Hurricane Fran in 1986 (Bin and Landry, 2013).

The DND technique does present limitations. Like Bin and Landry (2013) and Atreya et al. (2013), we used pooled sales data and associated hedonic property variables to control for factors that influence price unrelated to flood impacts. Such hedonic specifications can miss non-flood related spatial effects in the property market. Other works such as Beltran (2019) use a panel constructed from repeated sales of the same property, which obviates the need for hedonic price controls. While such repeat-sales techniques have a clear advantage in controlling for property characteristics and spatial effects, they also require 'thick' property markets with sufficient repeated sales of the same properties both inside and outside flooded areas. While they may be optimal for studies covering larger property markets, our analysis of largely non-urban U.S. counties leads us to opt for the pooled-sales DND approach.

Analysis

Our pooled data were organized into a regression equation to answer two specific research questions. First, is there evidence of price discounting in floodplains following flood events in our case study counties? Second, if such discounting is detected, what is its duration – i.e., how much time does it take for prices in the floodplain recover to the level of their non-floodplain counterparts?

A semi-log DND regression model was constructed to detect post-event price discounting within floodplain areas using pooled sales data from before and after the flood event. The regression equation was specified as:

$$\mathbf{X} = \beta_0 + \beta_1\mathbf{H} + \beta_2\mathbf{F} + \beta_3\mathbf{T} + \beta_4\mathbf{FT} + \varepsilon$$

where X is the natural log of the sale price; H is a matrix containing hedonic variables including building area, lot size, building age, and sale year; F is a binary variable indicating presence within the floodplain, T is a binary variable indicating a sale that has occurred since the flood event, and FT is the product of F and T such that it uniquely identifies sales that occurred after the flood and inside the floodplain (the difference-in-difference). Thus, the coefficient β_4 isolates the unique effect of the flood event on floodplain properties (Wing et al., 2018; Bin and Landry, 2013). As in Atreya et al.'s analysis (2013), we also extended the model to capture any price rebound within the floodplain after the flood. We added an interaction term that is the product of the number of years elapsed since the flood and the binary variable FT, such that the equation becomes:

$$X = \beta_0 + \beta_1 H + \beta_2 F + \beta_3 T + \beta_4 FT + \mathbf{\beta_5 YFT} + \varepsilon,$$

where coefficient β_5 indicates yearly price recovery, if any, among flood-affected properties.

Results

This section presents results from DND regression models for each county, with Table 2.1 presenting summary statistics for key model inputs, and Table 2.2 summarizing the model outputs.

Prior to running the regression models, we performed some necessary data manipulation on our input variables. First, we removed extreme outliers in sale price so that our dataset included only sales of between $50,000 and $5,000,000. This removed sales that, on the low end, might reflect intra-family transfers or dilapidated properties or, on the high end, might represent multifamily

or commercial properties that had been miscoded, or luxury properties that do not necessarily follow the same price hedonics. We also dropped residential sales associated with lot sizes of over 5 acres to make sure that the structure, rather than the land, represented the bulk of the value associated with the transaction. Finally, we inflation-adjusted all sales prices to 2012 dollars using the Bureau of Labor Statistics' CPI calculator. Table 1 summarizes the mean and standard deviation for the dependent variable *SalePrice* along with all key independent variables.

Table 2.1. Summary Statistics of Regression Input Variables

		Benton County		Boulder County		Cass County	
Variable	Description and Units	Mean	Stdev	Mean	Stdev	Mean	Stdev
SalePrice	Recorded sale price, adjusted to 2012 dollars	$285,213	$149,318	$431,517	$334,421	$210,822	$160,769
AfterFlood	1 if sold after the local flood event; 0 otherwise	0.468	0.499	0.34	0.474	0.948	0.222
100YearFZ	1 if in the 100-year flood zone; 0 otherwise	0.053	0.224	0.028	0.165	0.013	0.114
500YearFZ	1 if in the 500-year flood zone; 0 otherwise	0.057	0.232	0.068	0.251	0.462	0.498
Years	Years elapsed since the local flood event	1.3	1.7	0.57	1.06	4.52	2.26
DistDowntown	Distance from Urban Core (mi.)	7.1	6.1	13.4	8.2	6.8	3.3
MedianIncome	Census Tract Median Household Income (2012 ACS)	59011	20199	75746	27097	58275	15500
AgeAtSale	Structure age at sale date (years)	31.2	25.8	27.8	23.3	28.9	29.9
BldgSqft	Structure square footage (ft^2)	2036.6	1479.9	1724.9	1090.4	1586.7	2611.4
LotSize	Lot size (acres)	0.38	0.6	0.25	0.49	n/a	n/a
TotalRooms	Total rooms in structure	7.48	2.44	7.01	2.86	n/a	n/a
TotalBedrooms	Total bedrooms in structure	3.18	1.07	n/a	n/a	n/a	n/a
TotalBathrooms	Total bathrooms in structure	2.13	0.73	n/a	n/a	n/a	n/a

In accordance with previous work, and to control for variations in property price range between the three counties, we used the natural log of *SalePrice* as the dependent variable in the semi-log regression model summarized in Table 2.2. We also created logarithmic transformations of the distance from each county's economic center and Census Tract level household income, and

squared terms for property attributes including property age, building square feet, lot size, and number of rooms in the property. Finally, we included interaction terms in the form of multiplying both the 100- and 500- year floodplain variables by the binary variable indicating a sale after the flood (100- and 500YearFZ x AfterFlood), and by a linear term representing years elapsed since the flood event (100- and 500YearFZ x Years).

Table 2.2 shows each county's model results. Largely, coefficients were all in the expected directions. Model performance was generally good but mixed, with Boulder County performing best (Adjusted $R^2 = 0.7065$) and Cass County performing worst (Adjusted $R^2 = 0.513$).

Presence in the floodplain showed negative coefficients in all counties, with the price effect of being in the 100-year floodplain ranging from a price discount of 9.4% in Boulder County to 6.1% in Cass County. The discount associated with locations in the 500-year floodplain ranged from 7.3% in Benton County to 4.8% in Boulder County. The effect of floodplain presence was statistically significant at a 99% confidence level across all counties and floodplain designations apart from the 100-year floodplain in Cass County.

Coefficients on the interaction terms, however, suggest a more limited effect of post-flood price discounting than we initially hypothesized. Our model only found evidence of statistically significant post-flood price discounting in Boulder County, and only in the 100-year floodplain, where the coefficient indicated a post-flood price discount of 6.26% at a 99% confidence level. Post-flood prices in the 500-year floodplain in fact show significant price appreciation in all three counties, with appreciation of 7.6% in Cass County at 99% confidence.

Table 2.2. Regression Model Results

Variable	Benton County Est. [Std. Error]	Boulder County Est. [Std. Error]	Cass County Est. [Std. Error]
100YearFZ	-0.094 [0.015] ***	-0.09404 [0.009] ***	-0.0613 [0.172]
500YearFZ	-0.073 [0.015] ***	-0.0477 [0.006] ***	-0.07 [0.025] ***
AfterFlood	0.0542 [0.0417]	0.033 [0.011] ***	-0.0122 [0.0889]
100YearFZ x AfterFlood	0.042 [0.0358]	-0.0626 [0.0224] ***	0.1555 [0.1819]
500YearFZ x AfterFlood	0.07 [0.0335] **	0.0377 [0.0156] **	0.0761 [0.0291] ***
Years	0.0221 [0.0008] **	0.0191 [0.0046] ***	0.0208 [0.0097] **
100YearFZ x Years	0.0008 [0.0101] **	0.0276 [0.01] ***	-0.0068 [0.0127]
500YearFZ x Years	-0.014 [0.009]	0.0061 [0.0072]	-0.0015 [0.0028]
ln(DistDowntown)	-0.1672 [0.0046] ***	-0.335 [0.0015] ***	0.0119 [0.0085]
ln(MedianIncome)	0.0562 [0.0076] ***	0.1803 [0.0035] ***	0.2104 [0.0135] ***
AgeAtSale	-0.0087 [0.0004] ***	0.0023 [0.0002] ***	-0.0023 [0.0004] ***
AgeAtSale^2	0.0559 [0.0035] ***	-0.0376 [0.0017] ***	-0.0186 [0.0035] ***
BldgSqft	-0.00008 [0.000005] ***	-0.00009 [0.000003] ***	-0.0014 [0.000003] ***
BldgSqft^2	0.0316 [0.0008] ***	0.0337 [0.004] ***	0.0448 [0.0006] ***
LotSize	-0.1593 [0.0161] ***	-0.2833 [0.0063] ***	
LotSize^2	0.5645 [0.0334] ***	0.8155 [0.0114] ***	
TotalRooms	-0.0296 [0.0085] ***	-0.0398 [0.0015] ***	
TotalRooms^2	0.1776 [0.0448] ***	0.3878 [0.0101] ***	
TotalBedrooms	-0.1045 [0.0184] ***		
TotalBedrooms^2	0.2628 [0.066] ***		
TotalBathrooms	0.1228 [0.01923] ***		
TotalBathrooms^2	-0.2171 [0.0489] ***		
Year fixed effects	Yes	Yes	Yes
Observations	14769	74085	14309
Adjusted R-Squared	0.5202	0.7065	0.513

*** p<0.1; ** p<0.05; *** p<0.01**

Coefficients on the hedonic control variables are largely in expected directions and nearly always at high levels of significance. In addition to property characteristics, neighborhood income was a strong influencer of sales prices, with a doubling in neighborhood income associated with an

18.0% increase in sales prices in Boulder County, and a 21.0% increase in sales prices in Cass County.

Yearly Effect Summary

In Boulder County, the 2013 flood event was associated with a subsequent price discount of 6.26% for properties located in the 100-year floodplain. Figure 2.4 helps visualize the yearly rebound from this discount by plotting the fixed effects of the yearly post-flood interaction term on the predicted value of the average Boulder County property. The 6.26% drop represents nearly $27,000, and the interaction term shows an average increase of 2.76% ($11,900) per year. Thus, prices recovered to their pre-flood levels, on average, between two and three years after the 2013 flood.

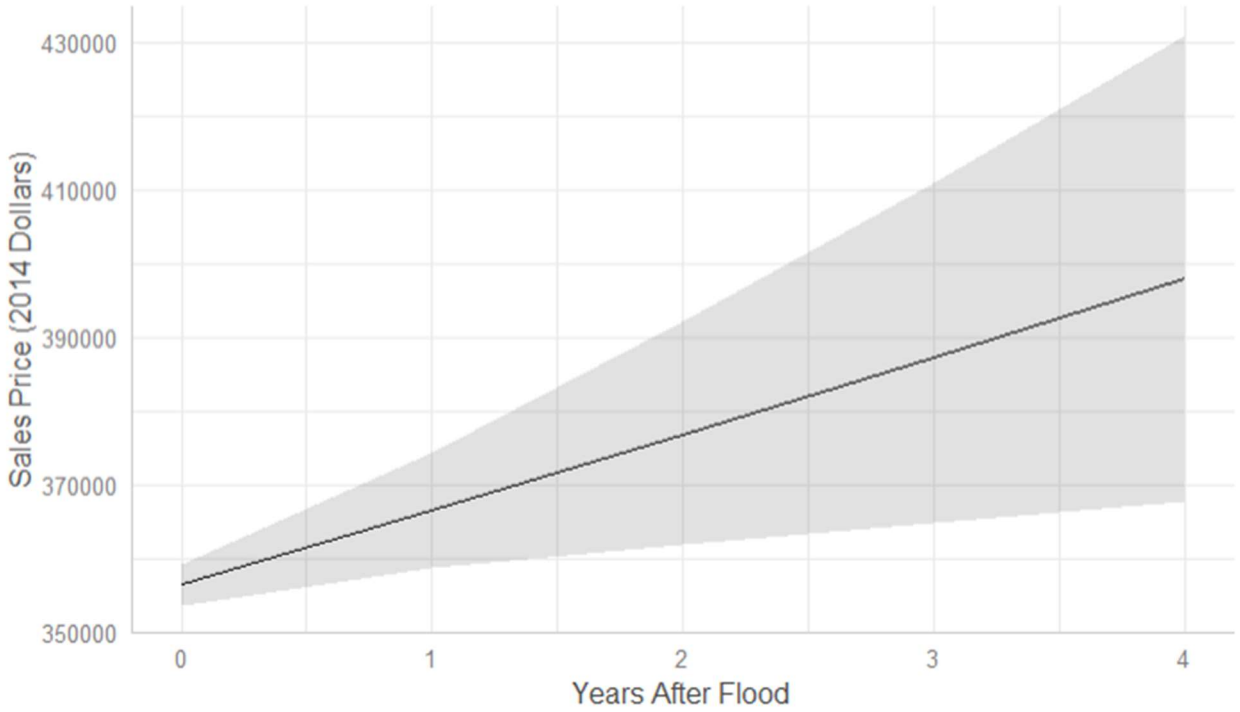

Figure 2.4. Unique effects of 100-year floodplain presence on property values in Boulder county, by year after flood event. The solid line shows the prediction, and the grey shaded area represents a 95% confidence interval around the prediction.

Discussion

The lack of significant price discounting following flooding in two of the three case studies here runs contrary to some previous research and warrants additional discussion. This section first details implications for Boulder County, CO and Benton County, CO, where models showed significant price discounting only in Boulder County's 100-year floodplain. Next, we discuss Cass County. Finally, we point out limitations of this study and point toward areas for future research.

Benton and Boulder County Case Studies

Previous studies have identified durations of post-flood price discounting lasting from as little as 1-2 years (Eves and Wilkinson, 2014; Lamond et al., 2010) up to 4-6 years (Tobin and Montz, 1997), followed by price recovery in the affected areas. In Boulder County, we identify post-flooding discounting followed by price recovery 2-3 years after the flood event, consistent with previous work on price discounting. Why was Boulder County the only county in our sample to experience statistically significant post-flood price discounting?

Initially, we hypothesized that Benton County and Boulder County might behave similarly. Both are home to major public research universities (Oregon State University and the University of Colorado, respectively) that comprise a large share of the counties' population, employment, and economic activity. Both Benton and Boulder counties are highly educated: 53.8% of Benton

County adults and 60.4% of Boulder County adults hold at least a bachelor's degree, compared to only 30.9% of all U.S. adults (Census Bureau, 2017). We initially hypothesized that prospective homebuyers in these counties might be, on balance, especially aware of natural hazard risks and perhaps less likely to forget the lessons of previous flooding. In that vein, we imagined that the floods in our study period would have incurred significant price discounting followed by long slow recovery periods or show little sign of recovery at all. The analysis, however, suggested that the local populations were already largely aware of their flood risk, so that the 2012 and 2013 floods had little impact on real-estate markets. Even before those flood events, floodplain properties in both counties were already discounted nearly 9.4%.

Ultimately only the 2013 flood in Boulder was associated with significant post-flood discounting on top of the pre-existing floodplain discount. The lack of such flood-related discounting in Benton County relative to Boulder County might also be a product of the relative lower severity of the 2012 storm in Oregon compared to the 2013 flash flooding event on Colorado's Front Range. A query of FEMA's publicly accessible claims database shows only 14 NFIP claims in Benton County in 2012 with a total value of $167,500, while a similar query of Boulder County for 2013 shows 1,511 NFIP claims totaling $48.6 million (FEMA, 2021). However, the difference in NFIP claims might also be at least in part due to differences in insurance take-up rates, or in the distribution of damage occurring within the regulatory 100-year floodplain, where properties are likely to carry NFIP policies, versus outside it. Nevertheless, even if the flood severity and demographics between both case studies are comparable, other work has shown that regional context can play an important role in determining the magnitude of post-flood price discounting: with such variables as inland versus coastal locations having significant effects during the same time periods (Beltran et al., 2019, 33).

Cass County Case Study

At the surface, our findings in Cass County appear to contradict the findings of Zhang (2016), which assessed flood effects on the real-estate market in Fargo-Moorhead after the 2009 flood using a spatial regression technique and found significant price discounting in affected areas during the first year after the flood. However, there are several important distinctions between Zhang's analysis and our own. Where Zhang used transaction data from a local MLS (multiple listing service) with a greater number of control variables, our paper uses data provided by Zillow, where transactions are primarily gathered from local assessor data. Some of the control variables used by Zhang were not available in our dataset and thus omitted from the hedonic regression here. Zhang also included over 8,000 transactions in neighboring Clay County, Minnesota (Moorhead), while our study is limited to Cass County. Zhang used a spatial regression model, where we use a simpler ordinary-least-squares regression model. Finally, our study considers effects within the 500-year floodplain as well as within the 100-year floodplain, whereas Zhang focused on the 100-year floodplain alone. A majority of the developed residential land in Fargo and West Fargo was within the 500-year floodplain as of the 2002 floodplain delineation (Figure 2.3), meaning that price effects are difficult to isolate statistically, and that homebuyers may not have had comparable property options outside the floodplain.

Additional confounding factors abound in Cass County, including the re-mapping of the Red River basin in 2015, when the statutory 100-year flood level increased, yet the amount of land designated in the 500-year floodplain decreased (Tran, 2015). Some of the properties in the floodplain according to the 2002 FIRM panels were re-mapped out of the floodplain, and the knowledge of pending re-mapping may have influenced sales prices. Perhaps the most important

factor to consider in Cass County is the proposed $2.75 billion Fargo-West Fargo Flood Control Project. Conceived as a response to the 2009 flood, the project is building a 30-mile long diversion channel around the western edge of the Fargo urban area and a large dam and retention area upstream, theoretically removing most urbanized portions (as well as large undeveloped areas) of the county from the floodplain. This project was in widespread discussion in the Fargo area in the wake of the 2009 flood, and we speculate that a widely-held belief that the project was inevitable led homebuyers to de-emphasize their property's floodplain designation. While the project faces an uncertain future pending ongoing litigation as of this publication (Gunderson, 2019), the idea that such large-scale flood protection might lower long-term flood risk is likely continuing to influence buyers' decisions throughout the Fargo region.

Limitations

This analysis is presented with several limitations. First, As Beltran et al. (2019) point out, there is an inherent flaw in nearly all attempts to link price changes to risk awareness: the price of flood-impacted properties is affected by not only the information update conveyed by the recent flood event, but by the cost of damages incurred by flood inundation itself. Therefore, we must acknowledge that some unknown portion of the significant flood discount in Boulder County is a product of flood damages, and not entirely a result of increased risk awareness.

Next, the timing of our analysis coincides with a major confounding variable – the global recession of 2009. While our regression controlled for macroeconomic "fixed effects" by using yearly binary variables, it is still possible that patterns observed during the recession and recovery might be different than patterns that would be observed in a period of economic

expansion. The analyses in Benton and Boulder counties, centered around flood events occurring in 2012 and 2013, respectively, should be relatively less affected by recessionary impacts, but even those analyses overlap with a period of uneven economic recovery.

More broadly, our analysis may be missing important regional variations that are harder to pick up using a straightforward empirical approach, including the role of local laws relating to flood hazard disclosure and subjectivities inherent in the appraisal process that ultimately affect sales prices in ways that are difficult to capture using hedonic variables and yearly fixed effects. Such qualitative variations in real estate valuations warrant their own analysis, and a qualitative approach that interviews appraisers and real estate agents in our case study geographies might yield novel results.

Finally, while we used a straightforward OLS regression employing a difference-in-differences technique to estimate price effects, other researchers have used alternative methods to overcome issues inherent to the OLS regression used in a spatial context. Zhang (2016) and Atreya et al. (2013) use spatial regression techniques, in which weights matrices are included in the regression to control for varying degrees of spatial autocorrelation between observations. Rajapaska (2017) used a combination of traditional parametric analysis with semi-parametric spatial measures to distinguish various regression fits according to spatial criteria such as distance from a shoreline or river. Others like Lamond et al. (2010) and Beltran (2019) used repeat-sales indices rather than hedonic regressions to examine price trends, which have the advantage of controlling for all property-level variations and spatial effects. There are a variety of analytical techniques that might be used with the ZTRAX database to estimate post-disaster price effects, and these should be explored in these case study counties and other areas.

Conclusions

This paper used the nationwide Zillow (ZTRAX) real-estate transaction dataset to investigate the effect of large flood events on residential home prices in three U.S. counties using a difference-in-differences model. Only Boulder County showed statistically significant price discounting after a flood event (6.26%), and only in the 100-year floodplain. However, our analysis was able to uncover price discounts for properties located in the 100-year and 500-year floodplains in all three counties both before and after the flood events we studied.

These results suggest that in some regions, including for the highly educated populations in Benton and Boulder Counties, risk awareness is widespread enough that floodplain property prices are discounted to a more appropriate level than in other locations. Our study found that floodplain properties in these counties were already 9.4% cheaper than comparable non-floodplain properties throughout our study period, in line with previous investigations including Kousky (2010), whose analysis did not find statistically significant price discounting following the Great Flood of 2013 in St. Louis, MO, but did find that a 4% flood risk discount was already priced into the market. Similarly, Pinter and Rees (2020) found that floodplain homes in small Midwestern towns appreciated at a rate 37% slower than comparable properties off the floodplain.

If indeed flood risks are increasingly being priced into the market without the help of a 'shock event' like a significant flood, the importance of floodplain discounting research becomes doubly important. While increased risk capitalization may be desirable when considering levels of overall risk exposure and the solvency of government-sponsored insurance programs, it also raises questions about how long-term risk exposure is related to housing affordability and uneven

impacts on different segments of society. It is ironic that increasing awareness of flooding and perhaps even a growing awareness of climate change may ultimately amplify the vulnerability of poor and minority communities to these hazards. Additional research should continue to test the impacts of risk awareness on real-estate prices and on the demographics of those residing in vulnerable areas, confirming whether the case studies presented here and in some previous works are isolated examples or signs of a wider trend.

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CHAPTER 3: Mapping the Disaster Diaspora: using Consumer Data to Understand Population Relocations Following the 2018 Camp Fire

Abstract

This analysis used household-level consumer databases to document population relocations in the wake of California's 2018 Camp Fire. Our team used this data to map the current location of over 8,000 households that had lived within the Camp Fire footprint in 2018. Based on block-level data from the 2010 Census data, we estimate that 13,879 households lived in the Camp Fire footprint before the fire across all ZIP codes. Using the study area defined above, we obtained data — including before-and-after addresses — for 8,112 of those households. Of those 8,112 sampled households, 4,947 (61.0%) remained within the fire perimeter as of 2022 (remained or rebuilt or relocated locally within the fire perimeter) while the remaining 3,165 households had relocated throughout California and the United States. We then used householder information to examine relationships between relocation distance and various measures of vulnerability including length of residence, householder age, and household wealth. Housing tenure and householder age were found to be predictive of relocation and relocation distance. Older householders were more likely than their younger peers to have relocated outside the burned area, and among those who relocated, were more like to have moved more than 25 miles (40.2 km) from the burned area. Those who owned their homes before the fire were more likely than renters to have relocated outside the fire footprint. In terms of relocation destinations, over half of Camp Fire survivors tracked in this analysis either continue to live in, or have moved to, areas with significant wildfire risk based on modeling by the California Department of Forestry and Fire Protection. Further, households with lower home values before the fire were more likely to

have relocated to very high wildfire threat areas. This project mapped the "diaspora" from California's most destructive wildfire event in history and explored the social determinants of relocation and hazard exposure, adding to a much-needed conversation about vulnerability and hazard risk in wildland areas in an era of climate change.

Introduction

After multiple years of unprecedented wildfire impacts in California, the 2018 Camp Fire remains a milestone event in California history. The Camp Fire claimed 85 lives and destroyed over 80% of the housing units in an urbanized area with nearly 40,000 residents. Previous studies have examined the link between social vulnerability and long-term displacement, but so far, this literature includes few examples from the realm of wildfire. This study used household-level consumer information from a data aggregating and marketing firm to map the "diaspora" of families from Paradise more than four years after the fire. Secondarily, this work examined potential household-level socioeconomic characteristics related to displacement distance and assessed the potential socioeconomic drivers of relocation into other areas with high wildfire threat.

Disaster Displacement Dynamics

Most studies of large-scale disaster-related displacement in response to natural hazards in the United States have focused on effects from hurricanes, especially in the wake of notable storms like Katrina in 2005 (Landry et al., 2007; Levine et al., 2007) and Maria in 2017 (DeWaard et al., 2020). Common themes in examining displacement from these large disasters include a lack of

long-term government support systems and/or housing assistance beyond temporary shelters provided by FEMA, and a lack of work on relocated or otherwise displaced communities, with more focus instead on rebuilding efforts in the affected areas.

The dynamics of displacement are byproducts of both the physical hazard itself as well as the social systems in which the hazard is rooted. These complex social contexts tend to reproduce uneven outcomes across race and class (Paul et al., 2024). In an empirical analysis of inter-regional migration amid large disasters in the United States, Elliot (2015) found that all racial and income groups were more likely to out-migrate from a given region following a large disaster, but non-white and lower-income populations were more likely to out-migrate and eventually become permanently displaced from affected regions. In studies performed after Hurricane Katrina, numerous researchers found associations between age and long-term relocation, with older residents more likely to remain and/or return to the disaster-affected area (Groen & Polivka, 2010; Hu et al., 2019; Vigdor, 2007), consistent with results from other types of disasters (Paul et al., 2024).

Studying disaster-related relocation in a highly mobile society such as the United States poses its own challenges. Around 10% of the American population moves every year (Newbold, 2021). Migrants tend to favor destinations where they have pre-existing family members or extended families, particularly when moving over long distances (Mulder & Cooke, 2009; Spring et al., 2017). This preference appears to be expressed roughly equally across socioeconomic groups, but the ability and resources to move toward distant family members (or move at all) has been correlated with advantaged socioeconomic positions (Spring et al., 2017). In a regional context, people in the American West were more likely to move in-state or nationally relative to their Midwest and East Coast peers, though this might be a product of larger county and state

geographies typically found in the West (Garasky, 2002). While early studies focused on individual decision-making and job-related concerns, more recent works conceptualize moving as the product of joint decision-making and 'linked lives' with partners, roommates, family members, and coworkers as crucial participants in relocation decisions (Coulter et al., 2016). There has also been a growing understanding that jobs and economic opportunities are just one category among many important motivating factors. Other such factors include "amenities" offered by different destinations (Clark & Maas, 2015), which could include an attractive natural environment (Chen & Rosenthal, 2008), or favorable social climates. For example, "creative class" workers tend to cluster in high-cost, socially progressive urban areas (Florida, 2003). In the wake of the COVID-19 pandemic, greater acceptance of telework has led to even greater decoupling of residential location decisions from workplace location (Ilham et al., 2024).

Less than 1% of moves that occurred within the United States in 2018-2019 were the result of natural disasters (Newbold, 2021, p. 133). Each of these disaster-related moves represents a unique migration situation in which relocation is a necessity rather than a choice. Nevertheless, while displaced residents may not have had a choice about leaving, long-term relocation decisions are influenced by "pull factors" which may or may not relate to displaced residents' identity and resources. Marginalized populations have been conceived variously as either unable to move far from the affected area due to a lack of resources or contacts in other locations, or conversely as less likely to return as a result of scarce or expensive housing (Paul et al., 2024).

The communities affected by the 2018 Camp Fire present an interesting case. On the one hand, they lagged the state in income – compare Paradise's pre-fire median household income of $49,270 to California's average of $71,228 as reported in the 2018 American Community Survey, which suggest high vulnerability to long-term displacement. On the other, these fire-

affected communities were home to disproportionally older residents – compare Paradise's median age of 49.1 to California's median age of 36.3. Residents of Paradise were also more likely to identify as white and own their own homes (Longreads, 2018). Both the older age, predominantly white racial profile, and high homeownership rates of pre-Camp Fire residents would suggest lower vulnerability to long-term displacement (Paul et al., 2024).

Displacement Following the 2018 Camp Fire

The 2018 Camp Fire in Butte County, California was the most destructive and deadly wildfire disaster in California history. Subsequent to the fire, a number of researchers have examined the disaster and its impacts. In the immediate wake of the fire, Chase & Hanson (2021) used change-of-address and non-profit disaster aid information to study initial relocation destinations. Others have studied related topics such as evacuation decision-making during the fire (Grajdura & Niemeier, 2022), impacts to social services (Schulze et al., 2020), and water supply contamination (Proctor et al., 2020).

At the present time, more than five years after the fire, less than a third of Paradise's pre-fire population has returned to the area (Siegler, 2023). In the months subsequent to the fire, local governments enacted anti-price gouging measures, and FEMA supplied temporary housing to many displaced residents (Chase & Hansen, 2021), but there remains a long-term housing affordability and availability crisis both within the fire footprint and in nearby communities including Chico and Oroville (California Housing Partnership, 2024; League of California Cities, 2023). There remains a need to better understand where those other two-thirds of households have gone – and to examine socioeconomic drivers of residents' relocation decisions.

How to Measure Displacement

There are multiple ways to quantify disaster-related displacement, each with its own analytical advantages, drawbacks, and constraints. Plyer et al. (2010) reviewed various types of data that researchers can use to estimate displacement, including direct and indirect measures. Chase and Hanson (2010) used U.S. Postal Service (USPS) address forwarding information through the National Change of Address (NCOA) database, an example of a direct approach. Indirect approaches include observational data like traffic counts and school district enrollment in nearby districts, as well as other administrative data including driver and vehicle registration information and voter rolls. One limitation of change-of-address information is that it consistently undercounts households, as setting up mail forwarding with the USPS is inherently voluntary and may be declining in importance along with the decline of physical mail in general. Other observational and administrative data can be more reliable, but is often lacking precision: most often this data is aggregated to counties or Census Tracts, which limits the analyses that can be done (Paul et al., 2024; Plyer et al., 2010).

Additional digital and so-called “big data” approaches to understanding migration events have emerged in recent years. These include the use of geotagged social media posts (e.g., Jia et al., 2020), cell phone use information (Burke et al., 2022), and harnessing the power of large consumer credit and marketing databases (DeWaard et al., 2020). These last data sources are typically amalgamations of administrative and other information for anyone with a credit footprint in the United States, including past and present addresses gleaned from credit applications, utility bills, and other private (purchased) and public information. Such consumer credit data was used to study displacement from Puerto Rico to the US mainland in the wake of

Hurricane Maria (DeWaard et al., 2020). DeWaard's team used a sample of consumer credit data collected by Experian to examine the socioeconomic dynamics of displacement to the mainland, but address information in this case was anonymized to the Census tract level. Sub-Census tract level data holds the potential to precisely identify the physical and social characteristics of the locations households have been displaced to, but such information is often problematic (like USPS data) or prohibitively expensive to obtain.

Methods

Change of Address Data

This project used household records from DataAxle's proprietary consumer data program to trace family movement between January 2018 (pre-fire) and January 2022 (post-fire). This work was inspired by and extends Chase and Hansen (2020), who used a similar dataset to trace household movement out of Paradise as of one year after the fire. Our analysis traced movements out to 2022, and additionally used the consumer information included with the dataset to explore potential determinants of relocation and relocation distance via non-spatial attributes including household size, householder age, home value, and wealth level.

DataAxle offers household-level data by various geographies including counites and ZIP codes. We obtained household data for the two ZIP codes most impacted by the Camp Fire: 95969 (Paradise), and 95954 (Magalia). These two ZIP codes together comprise what locals refer to colloquially as "The Ridge," a wildland-urban intermix community with a pre-fire population of approximately 40,000 (26,000 within the incorporated Town of Paradise). Figure 3.1 displays the location of these ZIP codes relative to the Camp Fire footprint and the regional context within

Butte County in northern California. The figure also shows housing-unit density at the Census Block level.

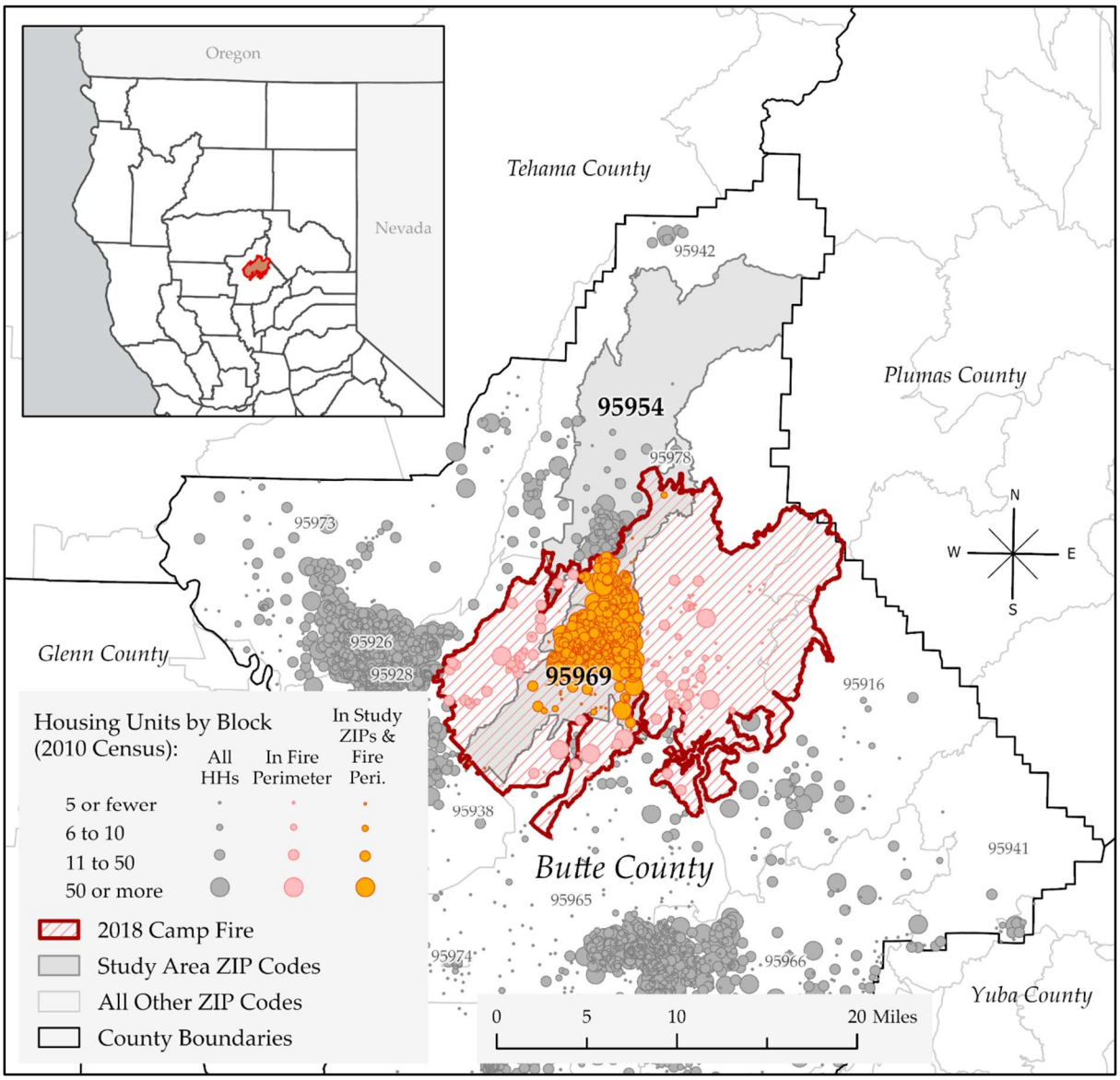


Figure 3.1 Study area ZIP codes 95969 (Paradise) and 95954 (Magalia) relative to the Camp Fire perimeter and Butte County. The figure shows housing-unit density at the Census Block level, including all housing units (grey), housing units in the fire perimeter (pink), and housing units in both the fire footprint and located in the 95969 or 95954 ZIP codes (in orange).

ZIP codes 95969 and 95954 were chosen for this analysis because they experienced the majority of fire impacts to populated areas, but the fire also impacted neighboring ZIP codes including

95928 (Chico) and 95965 (Oroville). These neighboring ZIP codes were not included as they also include large unaffected areas which would have made the data purchase prohibitively expensive. Table 3.1 summarizes the total population affected by the fire in all four affected ZIP codes by apportioning 2010 Census Block population into areas inside and outside the fire perimeter (also seen in Figure 3.1). More than 90 percent of Camp Fire survivors (32,000 people out of a total estimated population of 35,252) lived within the 95969 or 95945 ZIP codes.

Table 3.1 Pre-Fire Population of ZIP Codes Intersecting the Camp Fire Footprint

ZIP Code	Total Population (2010)	Population in the Camp Fire Footprint	% of Population in the Camp Fire Footprint
95969 (Paradise)	27,377	27,368	**99.97%**
95954 (Magalia)	11,939	4,634	**38.81%**
95965 (Oroville)	20,291	1,981	9.76%
95928 (East Chico)	36,751	1,269	3.45%

Based on block-level data from the 2010 Census data, we estimate that 13,879 households lived in the Camp Fire footprint before the fire across all ZIP codes. Using the study area defined above, we obtained data — including before-and-after addresses — for 8,112 of those households.

DataAxle's household-level data also contain limited household demographic information that was used throughout this report, including household size, housing tenure, and estimated median home values. First, it should be noted that only 8,112 households from 2018 were able to be matched with a location in 2022. This represents only 58.4% of the 13,879 estimated households within the fire perimeter across both ZIP codes, and just 47.4 percent of the 17,108 total households in both ZIP codes. However, it appears that the households for which new location

information is available are broadly similar to the overall population in terms of household size, tenure, and median home value (Table 3.2). Tracked households were, on average, smaller than Census data for the area (2.32 people per household versus 2.54 per household in the Census), slightly more likely to own their home (74.9% versus 73.4%), and had somewhat more valuable homes (median value of $233,900 versus the Census median of $203,101). Bias toward owner-occupied and wealthier households is expected in consumer or credit data, as those households are more likely to leave a traceable financial footprint (DeWaard 2020, Chase and Hansen 2020).

Table 3.2 Comparison of Households in DataAxle Database with American Community Survey Data for Paradise and Magalia, California.

	Households In DataAxle Sample (95969 + 95954; within fire perimeter)	95969 ZCTA (Paradise) 2018 ACS	95954 ZCTA (Magalia) 2018 ACS	95969 + 95954 2018 ACS Total or Weighted Average
Total Households	8,113	11,762	5,346	17,108
Household Size	2.32	2.34	2.98	2.54
% Owning Home	74.9%	71.1%	78.6%	73.4%
Median Home Value	$233,900	$220,600	$164,600	$203,101

Spatial Analysis and Statistics

This analysis utilized DataAxle household information to: 1) visualize the diaspora from Paradise by mapping recent addresses for households formerly within the fire footprint, 2) explore how displacement distance varies with household factors identified in other post-disaster contexts both individually and 3) in a multivariate context, and 4) assess the wildfire threat posed to displaced households in their post-fire residences.

Mapping the Diaspora

Mapping recent residential locations of households formerly within the fire footprint was completed by matching DataAxle's "FamilyID" from the 2018 and 2022 data queries. Addresses were geocoded in ArcGIS Pro using either the latitude and longitude coordinates provided by DataAxle, or, in a subset of cases with missing or incomplete address information, the centroid of the ZIP code associated with the record. Once geocoded in ArcGIS, additional attribute information was added to these household records using geoprocessing tools including the "Near Distance" function, which provided straight-line distances to the Camp Fire footprint, and the "Spatial Join" function to append the modelled fire hazard severity category of the address.

Associations with Distance

After the 2022 post-fire addresses were geocoded and distances from the Camp Fire burn area computed, these distances were then used as a dependent variable to test a whether a variety of household-level measures were associated with relocation distance. While a number of factors that have been shown as predictive of relocation outcomes in other disaster contexts including racial identity (Groen & Polivka, 2010) were absent or incomplete within DataAxle's attribute information, other potential indicators were present, including household size and tenure, and age and gender information for the primary householder. Age was an especially interesting variable, as the population affected by this fire was far above the national or state median age. Seven household variables, chosen due to their completeness in the DataAxle database and potential relevance as indicators of vulnerability and/or relocation determinations, were tested for

variance with distance. Table 3.3 shows these variables along with descriptions and describes the bivariate statistical test used to test associations with relocation distance. Data Axle's WealthFinder score (DataAxle, 2023) is an index based on indicators of household wealth provided by credit agencies, including real-estate holdings, investments, income, credit card expenditures, and householder education level. Possible values range from 0 to 3800+, with the greatest weight placed on real-estate holdings and income.

Table 3.3 Household Factors Available in DataAxle Dataset and Bivariate Statistical Tests Used to Determine Potential Relationships with Relocation Distance

Household Factor	Data Description	Bivariate Statistical Test vs. Distance
OwnVsRent	1 if the household is indicated as owning its home; 0 for all other arrangements	T-test
TenureYears	Number of years that the household has been located at this address	ANOVA (5 tenure groups)
HouseholdSize	Total number of persons in household (including children)	ANOVA
HouseholdChildren	Number of children living in the household	ANOVA
WealthScore	DataAxle's proprietary index of wealth based on assets and income; ranges from 0 to 3800	Linear correlation
FemaleHousehold	1 if the primary householder is female; 0 if not	T-test
HouseholderAge	Age of the householder as of January 1, 2018	Linear correlation; ANOVA (7 age groups)

Multivariate Modelling of Relocation

Because household attributes often display a high degree of collinearity, a more robust method for determining which household factors might be related to relocation outcomes is to construct a multiple regression model that considers each potential factor in relation to other potential explanatory variables. To this end, two binary logistic regressions were constructed to predict

two binary outcomes. The first regression used all households to assess if household factors can help predict a household's propensity to remain in the fire footprint in 2022 versus relocating outside the fire footprint. The second regression, performed only on the subset of households that relocated, assessed if those same household factors might be related to the distance a household relocated. Various distance 'break points' were assessed including 10 miles (16.1 km), 25 miles (40.2 km), 50 miles (80.5 km), and 100 miles (160.9 km), with 25 miles (40.2 km) ultimately chosen as a result of model performance, data evenness (roughly half of observations on either side of this line), and theoretical grounding as a typical regional commute distance. Households displaced within 25 miles might be thought of as "locally displaced" households which are likely to participate in pre-fire social networks, jobs, schools, and recreation, while those displaced beyond 25 miles may be less likely to remain so linked.

Mapping Fire Threat at Relocation Destinations

A secondary goal of this research was to understand to what degree emigrants from the Paradise Ridge region lessened their risk from wildfires, or if relocated households faced similar wildfire risks in their relocation destinations. To this end, CalFIRE's wildfire severity threat model was spatially joined in ArcGIS Pro to each relocated address point. This allowed for a summary of the count of households across the various wildfire threat categories and allowed a comparison of post-fire wildfire threat to the pre-fire household attributes examined elsewhere in this report. A series of bivariate statistical tests were employed to determine if any of the household factors used to predict relocation distance also had any influence over the fire threat of the relocation destination.

Results

Relocation Summary

This analysis traced current address information for 8,112 households that lived within the Camp Fire perimeter in 2018. Of those 8,112 households, 4,947 (61.0%) remained within the fire perimeter (remained or rebuilt or relocated locally within the fire perimeter), and 3,165 (39.0%) had relocated outside it. These households were traced to 43 states across the United States as of 2022, including Alaska and Hawaii (Figure 3.2). Figure 3.3 summarizes the count of households tracked to each state and county in California.

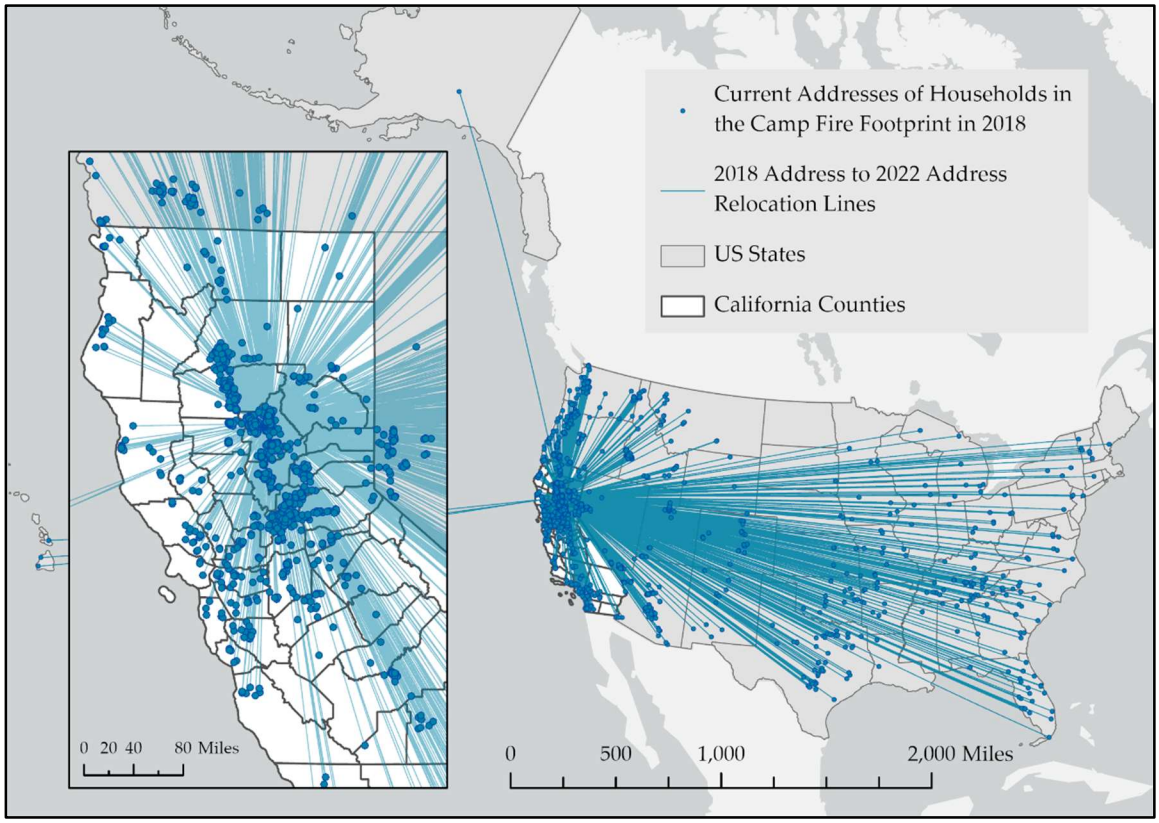


Figure 3.2 shows household relocation destinations throughout the United States (primary map) and in northern California (inset map). Blue dots show current household locations, connected by a blue line to their former addresses in Paradise or Magalia.

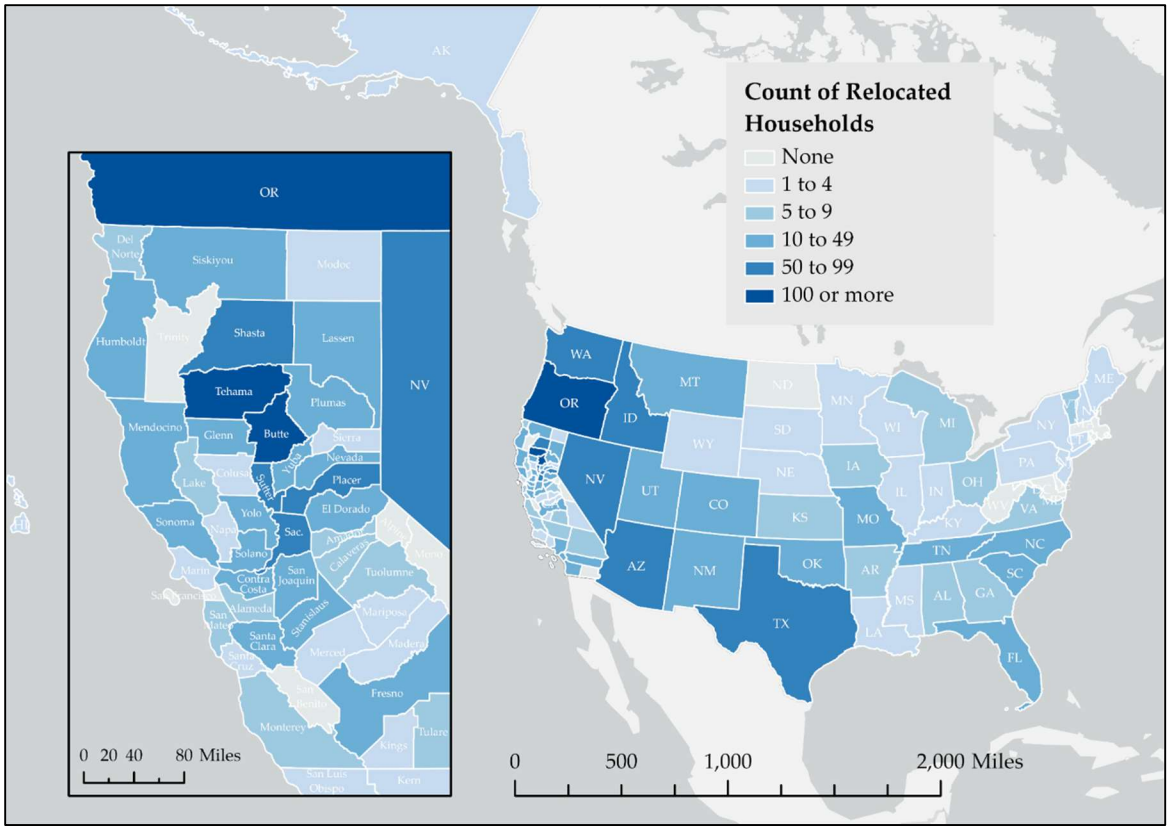


Figure 3.3 displays a count of relocated households throughout the United States (primary map) and in northern California counties (inset map).

More than three quarters of the 3,165 households which relocated outside the fire perimeter between 2018 and 2022 remained in California, with 2,454 (77.5%) of households showing a current residence with a California ZIP code (Table 3.4). Other popular states for relocated households include Oregon (136 households), Idaho (83 households), Arizona (76 households), Nevada (68 households), and Washington (66 households).

Table 3.4. Top States to which Camp Fire Survivors Relocated, as of 2022

Top 10 States	Household Count	Percentage
California	2,454	77.5%
Oregon	136	4.3%
Idaho	83	2.6%
Arizona	76	2.4%
Nevada	68	2.1%
Washington	66	2.1%
Texas	45	1.4%
Tennessee	27	0.9%
Florida	21	0.7%
Utah	20	0.6%
All Other States	*169*	*5.3%*

Examining the 2022 ZIP codes to which Camp Fire survivors relocated suggests that many households remain in the immediate vicinity of the burn perimeter. More than half– over 4,000 households - showed a 2022 address within Paradise, and an additional 1,250 households were found in the nearby Magalia ZIP code. It is likely that many of these "remaining" households are erroneous. As of 2023, there were less than 9,000 total people within the Paradise town limits (Siegler, 2023), which would suggest a realistic household count of less than 4,000 based on average household sizes. Unfortunately, "false positive" addresses are an inherent flaw with consumer data (DeWaard, 2020). These limitations are described further in the discussion section. Additional ZIP codes with large numbers of Camp Fire relocatees include those in the neighboring communities of Chico and Oroville, followed by communities in neighboring counties including Red Bluff and Yuba City. The most distant ZIP code with at least 10 Camp

Fire-affected households is the coastal community of Fort Bragg, at a driving distance of 189.5 km from Paradise.

Table 3.5. Top 30 ZIP Codes to which Camp Fire Survivors Relocated, as of 2022

ZIP	Community	Miles (km) from Paradise	Count of Households	Percentage
95969	Paradise	0 (0)	4,083	50.3%
95954	Magalia	1 (1.6)	1,250	15.4%
95973	Chico (North)	13 (20.9)	304	3.7%
95928	Chico (South)	12 (19.3)	234	2.9%
95926	Chico (Central)	12 (19.3)	163	2.0%
95966	Oroville (East)	18 (28.9)	129	1.6%
95965	Oroville (West)	17 (27.3)	96	1.2%
95967	Butte Creek Canyon	3 (4.8)	85	1.0%
96080	Red Bluff	45 (72.3)	56	0.7%
95927	Chico (Far North)	19 (30.5)	47	0.6%
95938	Durham	13 (20.9)	30	0.4%
95948	Gridley	27 (43.4)	28	0.3%
95648	Lincoln	61 (98)	25	0.3%
95991	Yuba City (East)	43 (69.1)	25	0.3%
95993	Yuba City (West)	44 (70.7)	24	0.3%
96021	Corning	32 (51.4)	24	0.3%
95963	Orland	31 (49.8)	20	0.2%
96007	Anderson	60 (96.4)	20	0.2%
95988	Willows	35 (56.2)	19	0.2%
96001	Redding (West)	71 (114.1)	19	0.2%
96002	Redding (East)	68 (109.2)	18	0.2%
96003	Shasta Lake City	74 (118.9)	16	0.2%
96055	Los Molinos	32 (51.4)	16	0.2%
95747	Roseville	71 (114.1)	12	0.1%

95765	Rocklin	70 (112.4)	12	0.1%
95901	Linda	45 (72.3)	12	0.1%
95953	Live Oak	35 (56.2)	12	0.1%
96022	Cottonwood	57 (91.6)	12	0.1%
95942	Forest Ranch	9 (14.5)	11	0.1%
95437	Fort Bragg	118 (189.5)	10	0.1%
		All Other ZIP Codes	1,300	16.0%

Overall, a majority (70.4%) of the 3,165 households that relocated outside the fire footprint remain within 160.9 km of the edge of the burn scar (Figure 3.4). Nearly half (46.4%) of these displaced households remained within 16.1 km of the burned area, primarily in unburnt portions of Magalia, along with Chico and Oroville as evidenced by the ZIP codes in Table 3.3. There is then a long-tailed distribution of households according to distance from the fire perimeter, with 938 households (29.6%) of households farther than 160 km from the perimeter and 216 households (6.8%) at least 1,610 km away from the burn perimeter as of 2022. The most distant household in the database was found in Scarborough, ME, over 4,200 km from Paradise.

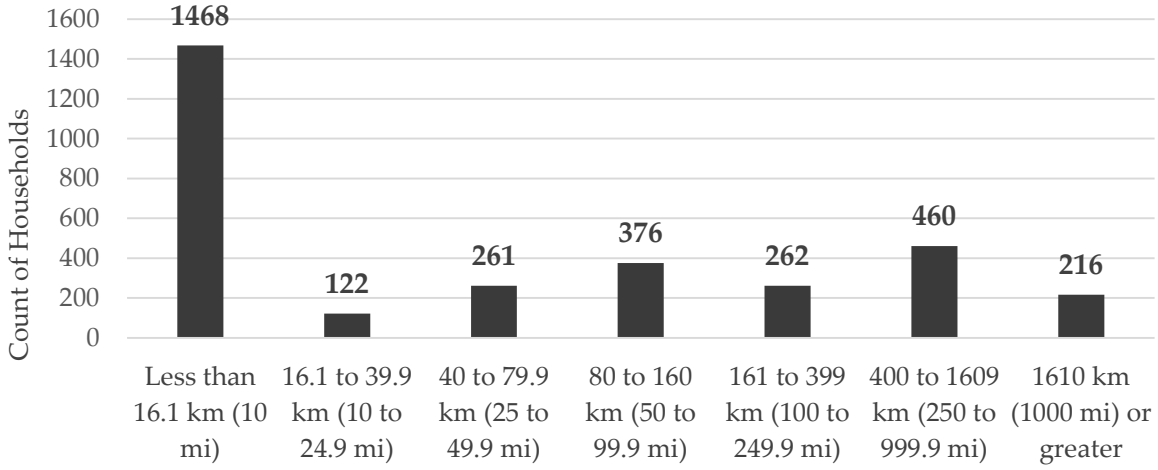


Figure 3.4. Relocated households by distance from Paradise (addresses within the fire footprint omitted)

This analysis also overlayed current addresses with wildfire threat levels (Figure 3.5) modelled by the California Department of Forestry and Fire Protection (CALFIRE, 2019). The goal of this analysis was to assess the potential fire hazards faced by Camp Fire survivors in their new communities, and if their relocation reduced wildfire exposure, both for individual residents and for California as a whole. In order to maintain precision, only households with information for 2022 that exactly matched to a geo-codable address were included in this portion of the analysis. Unfortunately, some 994 addresses were non-geo-codable or imprecise, often coincident with PO Box locations or street intersections rather than actual addresses, so these were omitted from this portion of the analysis. A further 711 addresses were omitted as they relocated outside of California and thus outside of the bounds of CALFIRE's model. This left 6,407 households for which current fire hazard severity could be determined.

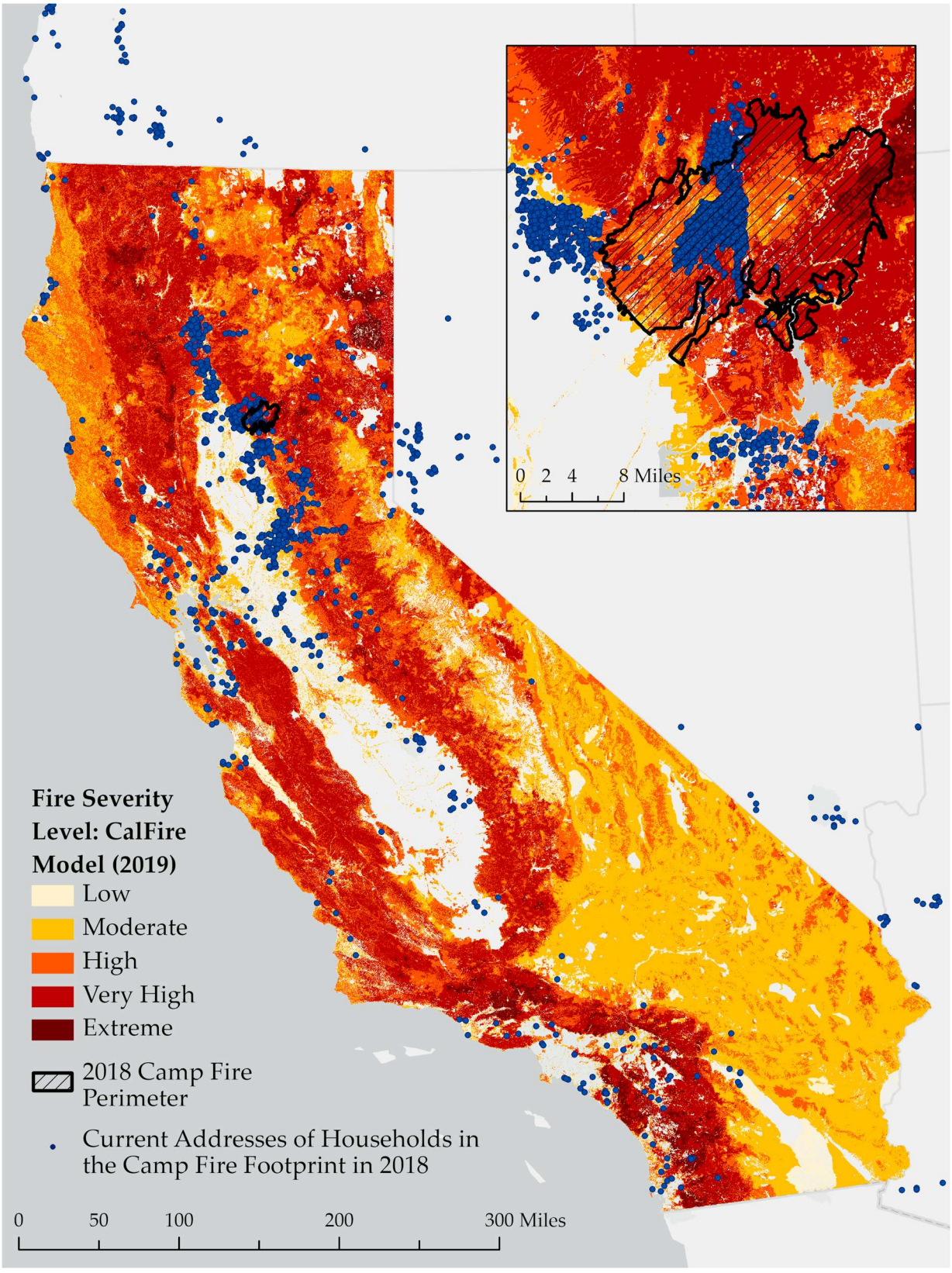
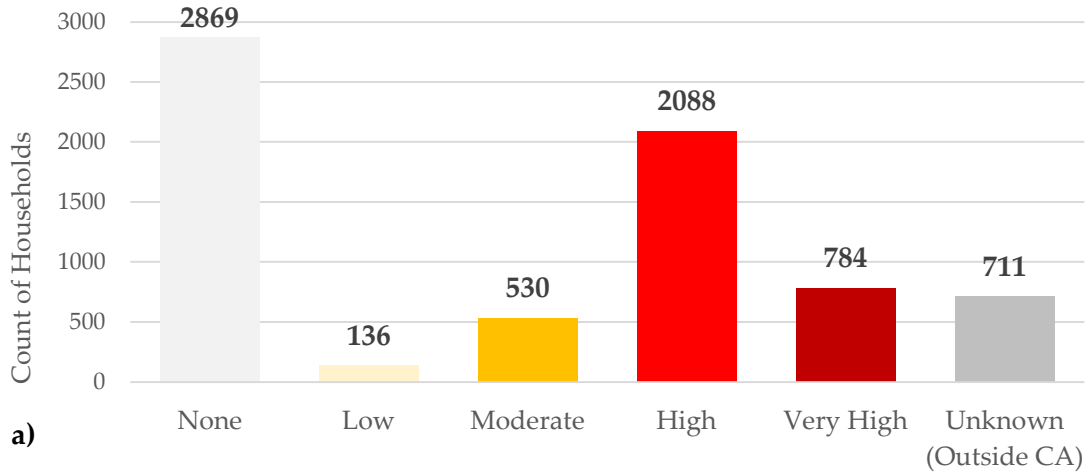


Figure 3.5. Relocated households relative to modelled fire severity throughout California (primary map) and in the vicinity of the Camp Fire (inset map).

Out of a total of 6,407 households for which modelled fire threat could be determined, 3,538 (55.2%) were in areas with measurable fire risk, and 2,872 (44.8%) were in either "high" or "very high" wildfire threat areas (Figure 3.6a). Many of the households found to be living in a high threat area in 2022 were those that remained inside the Camp Fire burn perimeter, so Figure 3.6b (below) disaggregates households based on presence inside or outside the burned area. Among the 2,793 households outside the Camp Fire perimeter for which fire threat could be determined, 400 (19.2%) were found in areas with some fire threat, with 279 of those (13.4%) located in areas with "high" or "very high" wildfire threat. For those households still living within the Camp Fire perimeter, it is worth noting that CalFire's most recent model information was produced in 2019, suggesting that the long-term threat classes used in this analysis may be under-estimated due to reduced vegetation loads following the Camp Fire, which occurred in November 2018.



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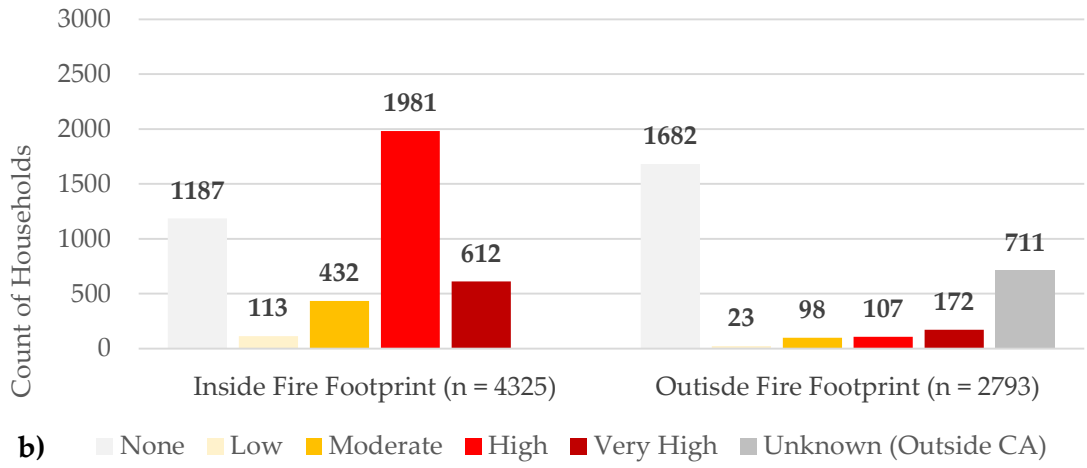


Figure 3.6. Relocated households relative to modelled fire severity; for all households (a) and split by households inside versus outside the Camp Fire footprint (b).

Relocation Distance by Household Characteristics

Overall, socioeconomic data contained in the dataset -- householder age, household tenure, household composition, and wealth indicators -- had limited ability to predict the distances households had moved away from the Camp Fire as of 2022.

The bivariate relationship between the age of the householder and distance moved (Figure 3.7) was not significant at the 95% level. While there appeared to be some variation in distances relocated by age--with households headed by an individual under 30 staying closer to Paradise than other groups--this relationship was not found to be statistically significant. A linear correlation between distance and age of householder yielded a very low Pearson's R value, with significance only at 80% confidence ($r = .018$; $p = 0.16$). Testing for significance by separating households into those with householders under 30 and householders 30 or above yielded similarly insignificant results ($p = 0.28$). Information on householder age was missing or

erroneous for 1,558 households, so this analysis was performed on a smaller universe of 6,554 households.

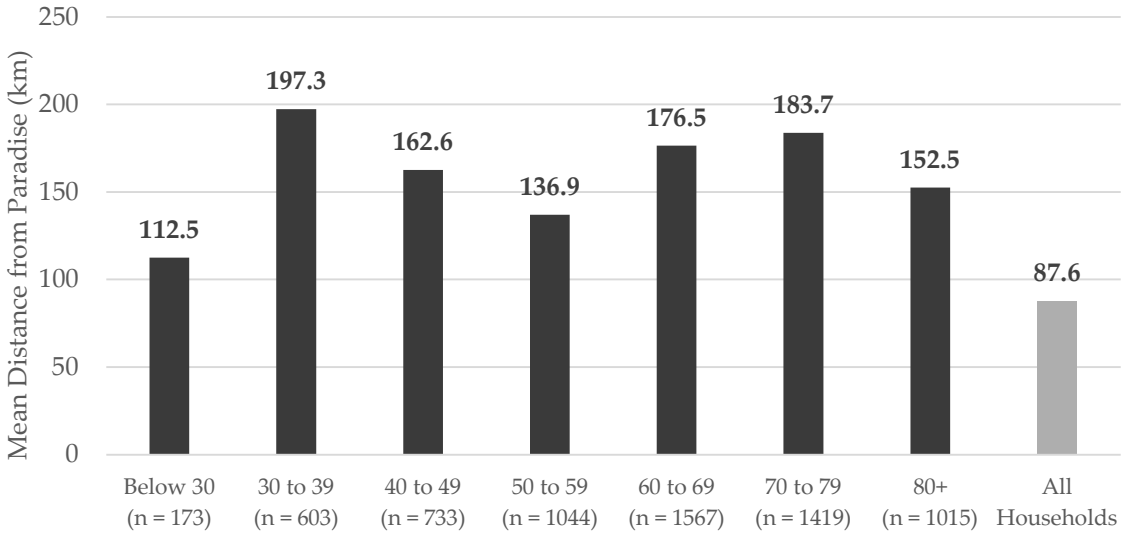


Figure 3.7. Mean distance from Paradise by age of primary householder.

On the other hand, household tenure (number of years households had spent at their address) was found to be predictive of distance moved (Figure 3.8). There is a significant ($r = -.036$, $p < .001$) negative correlation between household tenure (up to 2018) and the distance households moved as of 2022. A linear model predicting distance moved as a function of years at the same address revealed a coefficient of -1.6, suggesting that each additional year households had been at their 2018 residence was associated with living over 1.6 km closer to Paradise as of 2022. There was also a marked difference between owners and renters, with renters on average living over 64 km closer to Paradise as of 2022 ($p < .001$; 95% confidence interval = [-56.8, -24.4])

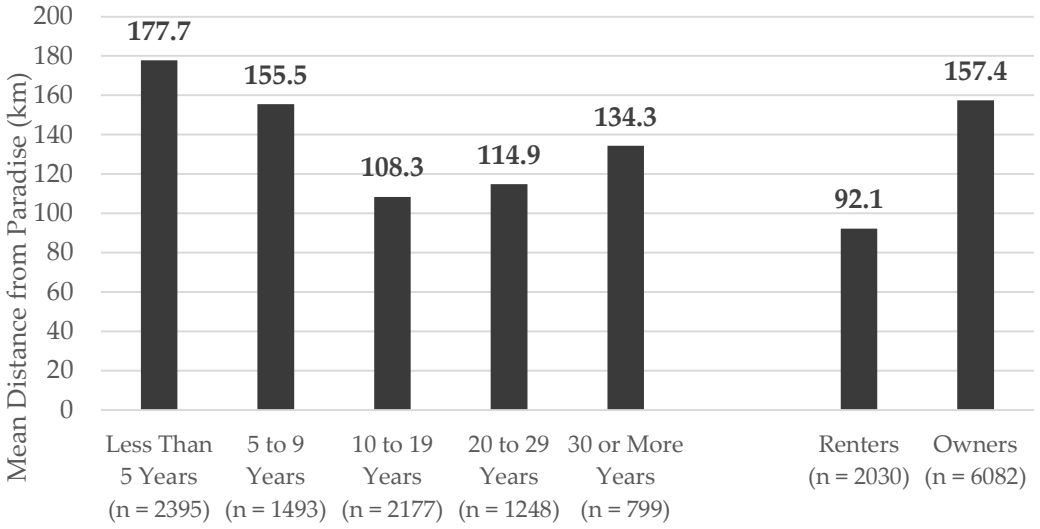


Figure 3.8. Mean distance from Paradise by household tenure characteristics.

Household size and the presence of children in the home was not significantly related to relocation distance (Figure 3.9). While households with children, especially those with two or more, were more likely to live closer to Paradise in 2022, a one-way ANOVA showed that this apparent association was not significant at a 95% confidence level ($p = .66$). A large majority of households in the dataset did not have children living in the home (80.5%), consistent with Census data and the Ridge's identity as a retirement community prior to the fire.

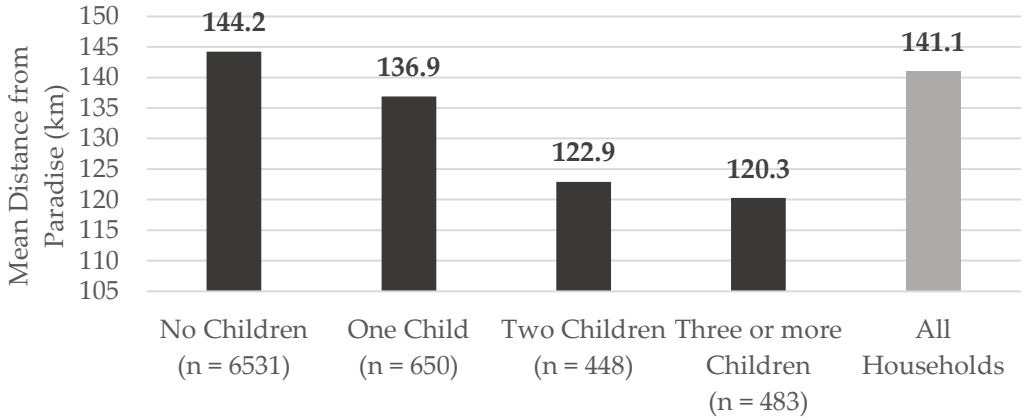


Figure 3.9. Mean distance from Paradise by number of children in the household.

Measures of household wealth were another potential influence on relocation distance (Figure 2.10a). There was a significant (at the 90% confidence level) positive linear correlation between DataAxle's proprietary WealthScore and relocation distance from the fire footprint (r = .019, p =.095). This suggests that for every 100 points higher on the WealthScore, a household was likely to live 5.3 km farther from Paradise. In contrast, 2018 median home value had no significant relationship with relocation distance. While home values appear to vary similarly with distance – and are in fact part of the composition of the wealth score – they were not significantly correlated with distance (Figure 3.10b).

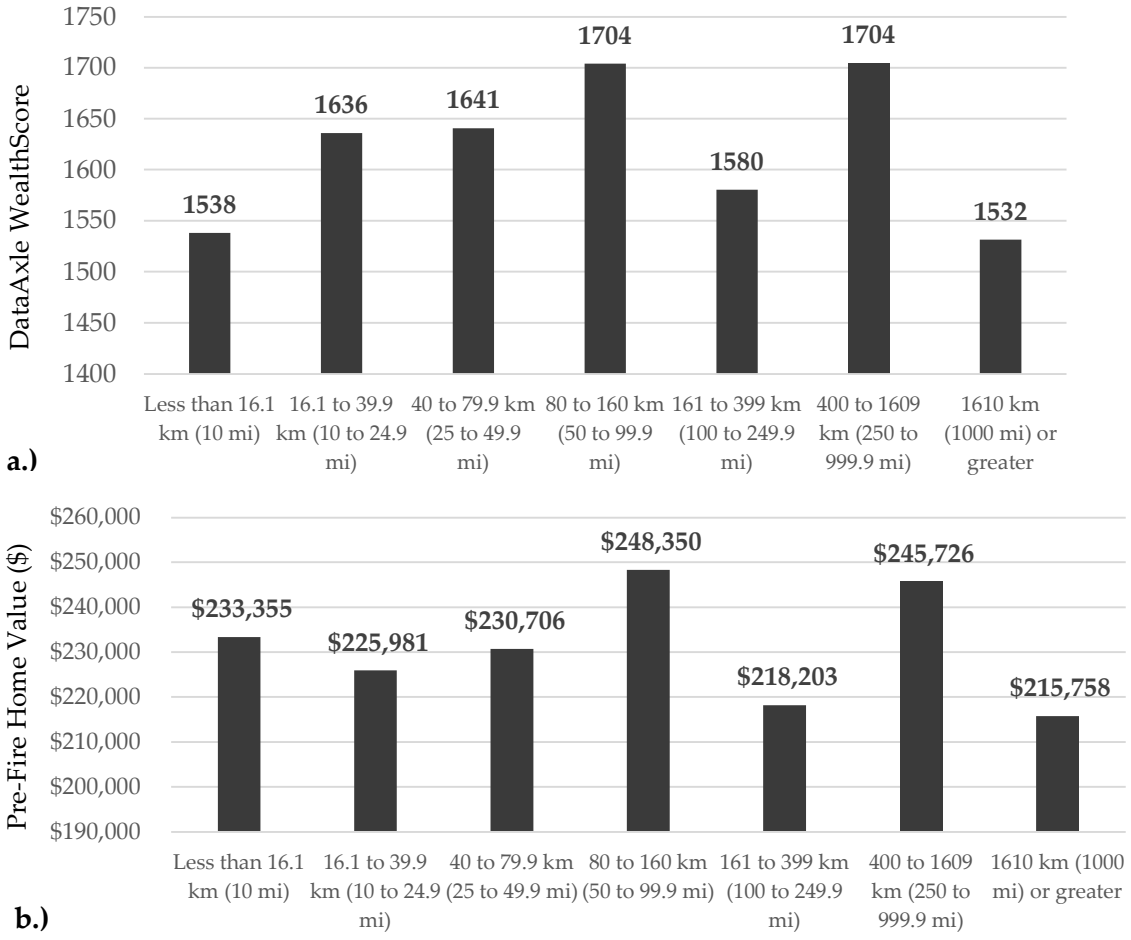


Figure 3.10. DataAxle WealthScore (a) and 2018 average home value (b) by distance from Paradise

Modelling Determinants of Relocation and Relocation Distance

This study used household characteristics included in the DataAxle dataset to predict two outcomes using binary logistic regression: first, households' propensity for remaining within the fire perimeter, and second, the likelihood that displaced households remained within 40 km (25 miles) of the fire perimeter. While the overall predictive capability of both models was low, numerous individual household factors were shown to have statistically significant relationships with these outcomes, including some that did not appear significant when examining bivariate relationships in the previous section.

6,108 out of 8,112 total observations were included in the model; households with incomplete address information (often only ZIP codes) or missing householder age information were omitted. Median home value is omitted as a predictor in this section because it is unreliable for non-owner households. Table 3.6 displays counts and means for seven household characteristics that were included in the first model, broken out by the 3,602 households still in the Camp Fire footprint as of 2022, versus the 2,506 households located outside the fire footprint.

Table 3.6. Potential Factors Predicting Likelihood of Remaining Inside the Camp Fire Footprint

Variable	Description	Still in Fire Footprint	Outside Fire Footprint
Within25 ***(Dependent Variable)***	1 if household is still located in the fire footprint in 2022; 0 if not	**n = 3,602** (58.97%)	**n = 2,506** (41.03%)
OwnVsRent	1 if the household is indicated as owning its home; 0 for all other arrangements	87.91%	89.06%
TenureYears	Number of years that the household has been located at this address	15.4	13.9
HouseholdSize	Total number of persons in household (including children)	2.3	2.4

HouseholdChildren	Number of children living in the household	0.54	0.47
WealthScore	DataAxle's proprietary index of wealth based on assets and income; ranges from 0 to 3800	1697	1716
FemaleHousehold	1 if the primary householder is female; 0 if not	39.8%	34.4%
HouseholderAge	Age of the householder as of January 1, 2018	59.7	62.0

A binary logistic model predicting the propensity for a household to remain in the fire footprint was not strongly predictive overall, as indicated by a Pseudo-R Squared value of .032 (Table 3.7). Nevertheless, five out of seven potential predictors were flagged as significant; four at 99% confidence and an additional factor at nearly 95% confidence. These findings augment some of the bivariate analysis conducted in the previous section and are helpful in exploring the potential influences of multicollinearity, even in the context of a relatively weak overall model. Housing tenure and the presence of children in the household stand out as two factors strongly predictive of a greater likelihood of remaining in the Paradise fire footprint, while total household size and householder age stand out as two factors strongly predictive of relocation outside the fire footprint.

Table 3.7. Results From a Binary Logistic Regression Predicting if a Household Remained in the Camp Fire Footprint as of 2022.

Variable	Coefficient [Standard Error]	Exponentiated Coefficient	P-Value
OwnVsRent	0.047 [0.096]	1.049	0.619
TenureYears	0.024 [0.003] ***	1.024	0.000
HouseholdSize	-0.172 [0.032] ***	0.842	0.000
HouseholdChildren	0.226 [0.047] ***	1.254	0.000
WealthScore	0.00002 [0.0001]	1.00002	0.708
FemaleHousehold	0.146 [0.052] *	1.157	0.017

HouseholderAge	-0.013 [0.002] ***	0.988	0.000
Constant	0.926 [0.141] ***	2.525	0.000

Nagelkerke Psuedo-R2: .032; n = 6,108

**p<0.1; **p<0.05; ***p<0.01*

Beyond the question of remaining in or relocating outside the Paradise fire footprint, binary logistic regression was also used to test inferences about the distances that households relocated. Table 3.8 displays counts and means for the same seven potential predictor variables used in the previous model for the 2,506 households outside the fire footprint in 2022 that had complete address and householder information. Among these households, fewer than half (1,109) were locally displaced within 40 km of the Camp Fire perimeter, while over half (1,397) were living beyond 40 km from the fire footprint.

Table 3.8. Potential Factors Predicting Likelihood of Remaining Within 40 Kilometers of the Camp Fire Footprint.

Variable	Description	Displaced Within 25 Miles	Displaced Beyond 25 Miles
StillIn ***(Dependent Variable)***	1 if household is displaced but still living within 25 miles of the fire perimneter; 0 if displaced but living beyond 25 miles	**n = 1,109** (44.25%)	**n = 1,397** (55.75%)
OwnVsRent	1 if the household is indicated as owning its home; 0 for all other arrangements	89.2%	86.9%
TenureYears	Number of years that the household has been located at this address	14.19	13.60
HouseholdSize	Total number of persons in household (including children)	2.57	2.20
HouseholdChildren	Number of children living in the household	0.62	0.35
WealthScore	DataAxle's proprietary index of wealth based on assets and income; ranges from 0 to 3800	1716.3	1715.8

FemaleHousehold	1 if the primary householder is female; 0 if not	35.2%	33.9%
HouseholderAge	Age of the householder as of January 1, 2018	59.0	64.4

This binary logistic regression predicting whether or not a displaced household stayed within 40 km of the fire footprint or relocated farther away performed better than the regression predicting if households remained within the fire footprint; achieving a Pseudo-Squared value of .062 (Table 3.9). Only three factors were predictive at 95% confidence: household tenure and female-headed households were positively predictive of remaining within 40 km, while householder age was negatively correlated with remaining within 40 km.

Table 3.9. Results From a Binary Logistic Regression Predicting if a Household Remained Within 40 Kilometers of the Camp Fire Footprint as of 2022.

Variable	Coefficient [Standard Error]	Exponentiated Coefficient	P-Value
OwnVsRent	0.162 [0.150]	1.176	0.2815
TenureYears	0.017 [0.004] ***	1.018	0.0001
HouseholdSize	0.095 [0.049] *	1.1	0.0511
HouseholdChildren	0.051 [0.074]	1.052	0.4899
WealthScore	-0.0001 [0.0001]	1.0001	0.5350
FemaleHousehold	0.205 [0.098] **	1.227	0.0365
HouseholderAge	-0.025 [0.003] ***	0.976	0.000000000000001
Constant	0.680 [0.228] ***	1.974	0.0029

Nagelkerke Psuedo-R2: .062; n = 2,506

**p<0.1; **p<0.05; ***p<0.01*

In an effort to align the different measures of whether or not a household factor was associated with an aspect of post-fire relocation, Table 3.10 summarizes the various tests presented in this

results section. We observed some differences between using bivariate measures (T-tests, one-way ANOVAs, or linear correlations) to measures associations with distance displaced as compared to using binary logistic models to assess each factor's individual contribution within a multiple regression model. Only one factor – the number of years the household had lived at its current address -- was strongly correlated with all three measures of displacement: distance (via a linear correlation), and propensity to remain within the fire footprint and to remain within 40 km if displaced (via binary logistic models).

Table 3.10. Summary of Relationships Between Household Factors and Relocation Metrics

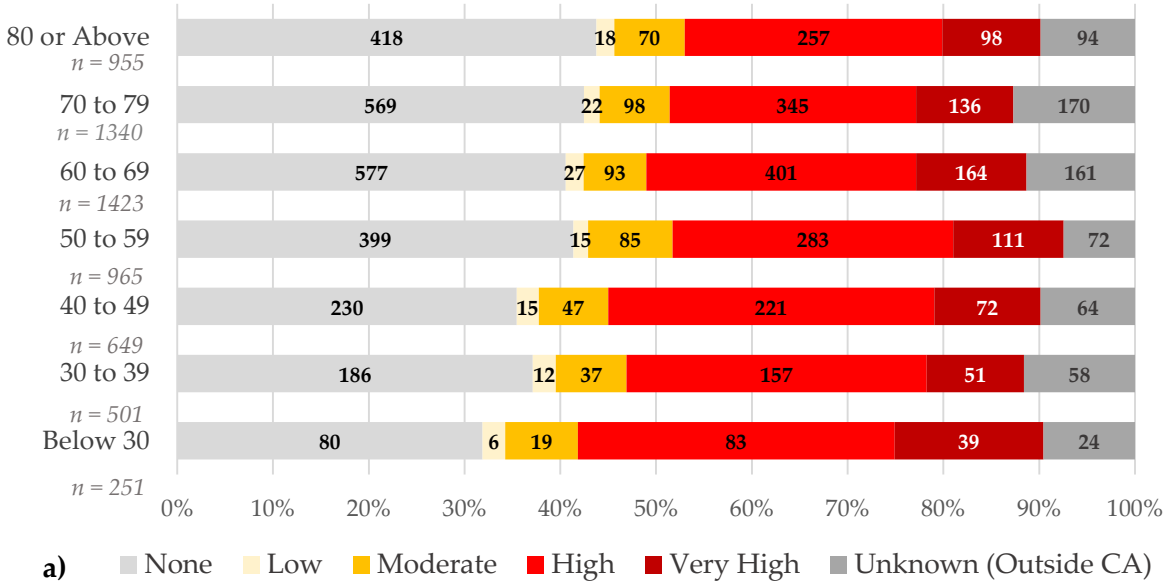
	Bivariate relationship with relocation distance (T-test, one-way ANOVA, or linear correlation)			**Binary logistic model: propensity to remain in the fire footprint**			**Binary logistic model: propensity for displaced households to remain within 25 miles of the fire footprint**		
Variables	**sig .9+**	**p**	**dir.**	**sig .9+**	**p**	**dir.**	**sig .9+**	**p**	**dir.**
OwnVsRent	yes	<.01	+	no	--	n/a	no	--	n/a
TenureYears	yes	<.01	−	yes	<.01	+	yes	<.01	+
HouseholdSize	no	--	n/a	yes	<.01	−	yes	<.10	+
HouseholdChildren	no	--	n/a	yes	<.01	+	no	--	n/a
WealthScore	yes	<.10	+	no	--	n/a	no	--	n/a
FemaleHousehold	no	--	n/a	yes	<.10	+	yes	<.05	+
HouseholderAge	no	--	n/a	yes	<.01	−	yes	<.01	−

Fire Risk Level in Relocation Destinations

This analysis also investigated the relationship between household characteristics and the predicted level of fire threat at each household's post-fire (2022) address. The data indicate that

the age of the householder and each household's median home value in 2018 were significantly associated with household's exposure to wildfire threat at their relocation address.

The ages of householders were significantly associated with post-relocation fire threat, with younger householders more likely to be living in wildfire threat areas in 2022 (Figure 3.11). A one-way ANOVA was performed to compare the ages of householders in each wildfire threat zone to one another, and it suggested that householders in the moderate, high, and very high wildfire threat zones were significantly more likely to be younger than householders in areas with no wildfire risk.



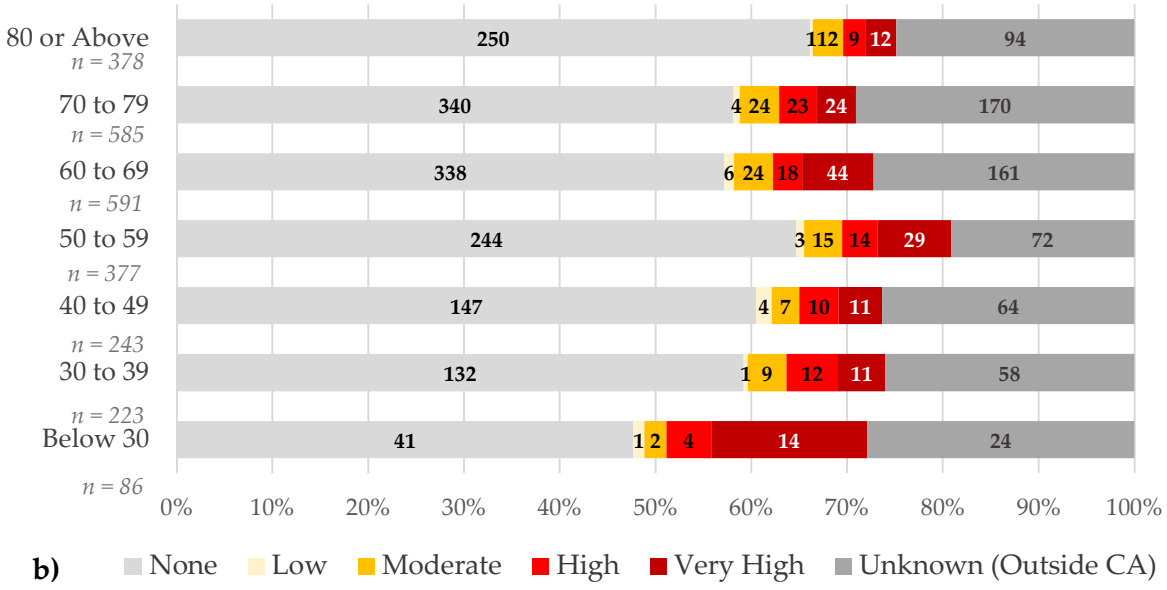


Figure 3.11. CalFire wildfire threat zone of 2022 household location by age of primary householder for all households (a) and for households that relocated outside the Camp Fire footprint (b).

Householders in the moderate wildfire threat group averaged 2.8 years younger than those in the no-risk group (p = .014, 95% confidence interval = [-5.18, -.35]). Those in the high wildfire threat group averaged 3.3 years younger than those in the no risk group (p = <.001, 95% confidence interval = [-4.75, -1.80]). Finally, households in the very high wildfire threat group averaged 2.7 years younger than those in the no risk group (p = .003, 95% confidence interval = [-4.7, -.60]).

Measures of household tenure appeared to vary less with current wildfire threat zones (Figure 3.12). Neither the years in residence at the address or ownership was significantly associated with current threat classes as determined by a one-way ANOVA (for years in residence) and a Chi-Squared test (for ownership).

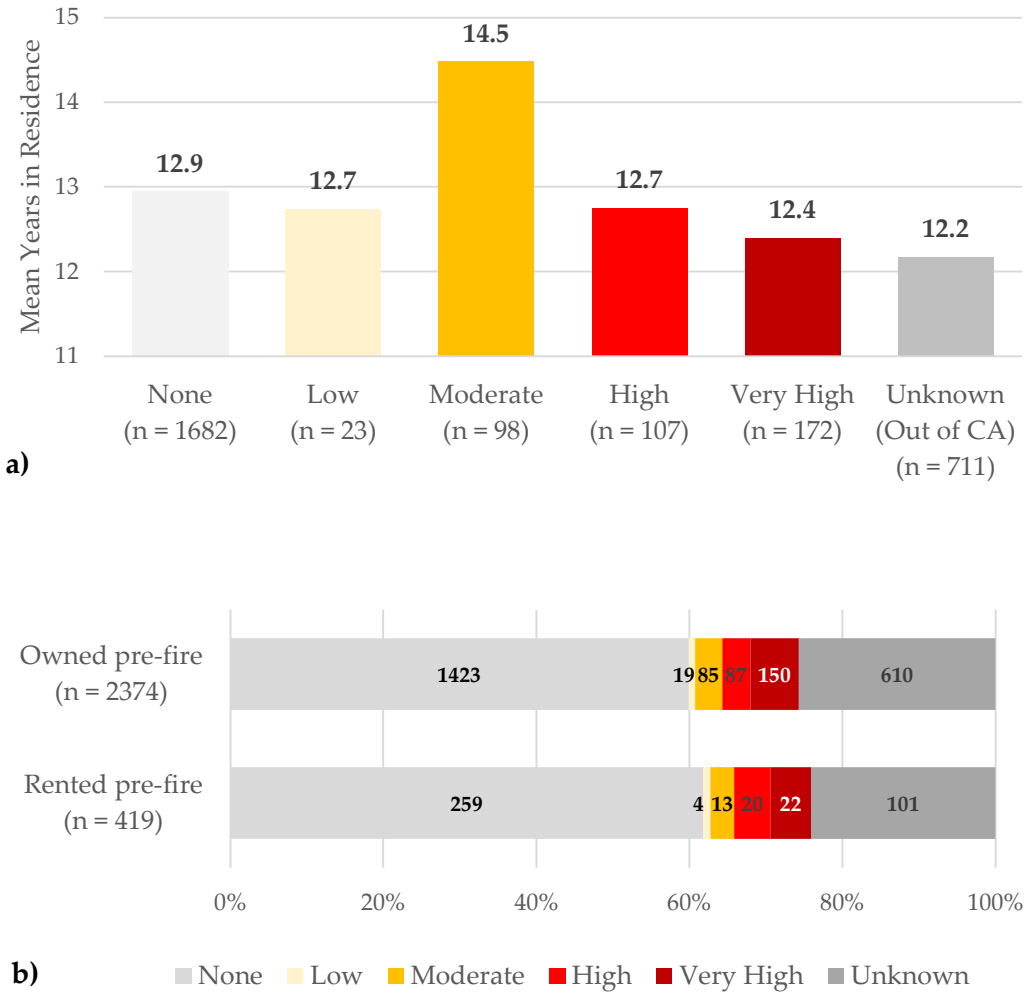


Figure 3.12. Post-relocation fire threat level by home tenure: years in residence (a) and ownership (b).

The relationship between the number of children in the home and current wildfire threat class was inconclusive (Figure 3.13). While the percentage of households with three or more children living in very high wildfire threat areas (8.3%) was slightly higher than the percentage of households with no children living in those same high wildfire threat areas (5.6%), a one-way ANOVA did not reveal any significant differences in the distribution of wildfire threat areas between these groups.

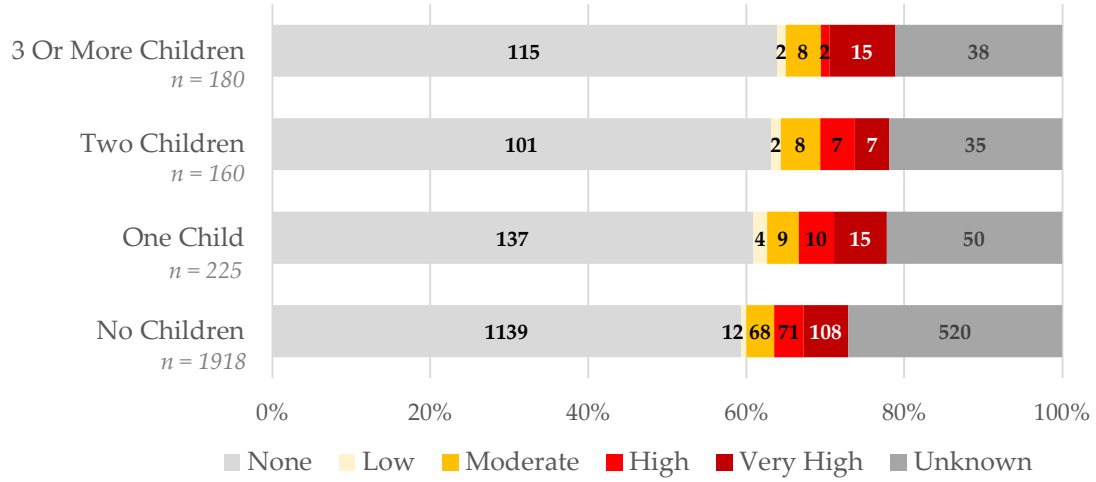


Figure 3.13. Post-relocation fire threat level by number of children in the household.

Finally, wealth indicators were found to be significantly correlated with wildfire threat classes for current addresses (Figure 3.14). For DataAxle's wealth score, a one-way ANOVA revealed a significant relationship between score and fire threat class ($p = 0.04$), but a post-hoc analysis did not flag any significant relationships among wealth score between individual threat classes. More importantly, a one-way ANOVA performed on households' median home value in 2018 also revealed a significant relationship with current fire threat ($p = 0.02$), with post-hoc tests showing a significant difference between the 2018 median home value of those that relocated to very high fire threat areas and those in areas with no wildfire threat. On average, households that relocated to very high fire threat areas had home values more than $20,000 less than their counterparts in areas with no modelled threat ($p = 0.02$, 95% confidence interval = [-$57,665, -$2,962].

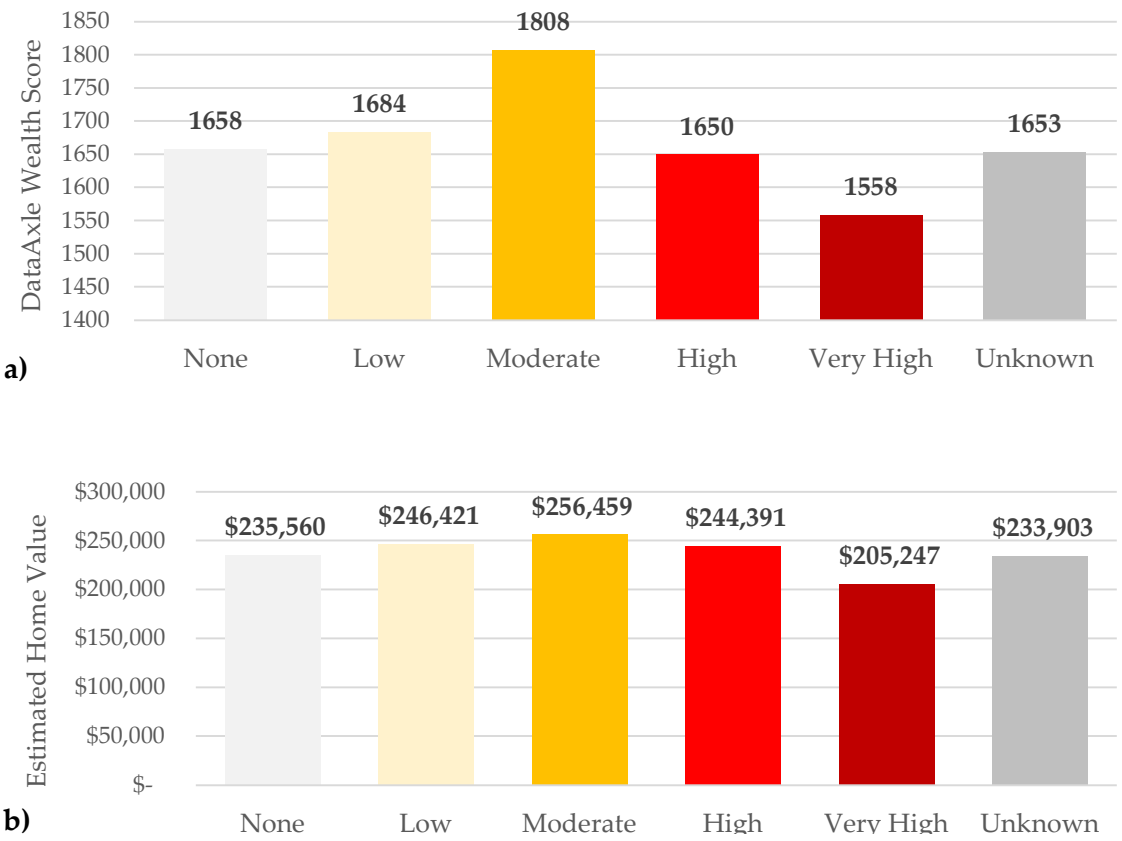


Figure 3.14. Post-relocation fire threat level by DataAxle's WealthScore (a) and median home value (b).

Discussion

Gilbert White (2001) posited that populations exposed to hazards tend to belong to one of two groups: those who occupy hazardous areas because they have the resources to adapt to the environment, and those who live in these areas because of social and economic marginalization. We often imagine that those affected by California wildfires belong to the first group; and recent empirical work has deemed that this is often the case (Schumann et al., 2024). However, this analysis shows that many of those affected by the Camp Fire belonged to the latter group – and that social and economic marginalization played a role both in limiting the ability to stay and rebuild in the region, and in making it more likely that these households relocated to areas with comparably high wildfire risks. As California communities continue to grapple with land-use approaches to wildfire risk reduction, these results further highlight the need for affordable housing outside of climate-driven risk areas.

Mapping the Camp Fire Diaspora

This analysis analyzed a "diaspora" of former Paradise-area residents to other communities throughout California and the United States. The use of the term "diaspora" here is intentional, through both its origins meaning "to spread about", and in the context of a people with shared history and culture who have scattered far from their homelands by necessity, not by choice. The scattered nature of this displacement might be contrasted with more guided approaches referred to variously as "managed retreat" or "resilient relocation." These strategies have been used variously in the context of flood recovery in the United States (Pinter, 2021; Pinter & Rees, 2021), and tsunami recovery in Japan (Pinter et al., 2019). These strategies aim to purposefully

reduce hazard exposure while keeping communities intact, as displaced residents move together to new locations, often with government funding and/or support (Siders et al., 2019). Managed retreat strategies have not yet been used successfully in a wildfire recovery context in the United States.

Instead, recovery from the 2018 Camp Fire has been markedly "unmanaged". A substantial portion of the relocated households tracked in this study moved to distant regions in California and nationwide. While this analysis did not focus on specific 'hot spots' for relocation, numerous clusters are evident in places like Medford, Oregon, Boise, Idaho, San Antonio, Texas, and Knoxville, Tennessee. These results build on earlier work by Chase and Hansen (2020), suggesting that many relocations in the initial years after the fire have become permanent. The household data used in this analysis revealed some socioeconomic trends in displacement and displacement distance, but survey data is needed to better understand the choices and preferences behind relocation destinations.

This project also studied the fire exposure at the sites to which emigrees from the Paradise area relocated, using a CalFire model of wildfire threat. In this analysis, 55.2% of households, including households that remained within the fire footprint, still lived in sites in California with wildfire risk. Excluding households that remained or rebuilt within the Camp Fire footprint, 19.2% of emigrees from the Camp Fire moved to another California location with documented wildfire risk (in a sense, "out of the frying pan, and into the fire"). These results track with recent work showing that the number of households exposed to fire continues to grow both within California and throughout the American West (Modaresi Rad et al., 2023). Yet it is still surprising that so many residents, having lived through the most destructive wildfire in California history, remain in areas with this threat. It is possible that many residents are so tied to

Paradise and the Ridge communities that they remain emotionally bound to this location or other areas with similar environmental and social characteristics. This "place attachment" effect has been documented widely in post-disaster settings across the United States and among many disaster types (Dandy et al., 2019; Greer et al., 2020). Perhaps these residents view future wildfire risk through a "gambler's fallacy" lens as documented by Mockrin (2015), erroneously believing that because a disaster already happened once, it won't happen again. To that end, it should be mentioned that many areas destroyed by the 2018 Camp Fire have once again been threatened and faced evacuations during the summer of 2024's Park Fire, where different wind conditions could have spelled a second disaster for Paradise and the Ridge (Parker, 2024)

Perhaps, on the other hand, the "choice" to remain in areas threatened by wildfire is not a choice at all. The real-estate landscape in California is such that in many metropolitan areas, developments in forested areas on the fringe of major cities are more affordable than relatively safer urban core areas (Greenberg, 2021; Méndez et al., 2020). In 2018, Census data reveals that the median monthly housing cost for residents of Paradise was just $959 compared to a monthly median cost of $1,193 in nearby job-center Chico, which lies in the Sacramento Valley and exhibits far lower fire risk. Housing types were markedly different in the two communities as well, with only 4.2% of Chico's occupied housing units comprised of mobile homes, versus 17.1% of Paradise's occupied housing units. Mobile homes can provide relative affordability, but typically lack durability and resale value, and are often uniquely vulnerable to natural hazards such that they are often explicitly included in hazard models to suggest increased vulnerability (Rumbach et al., 2020). These differences in pre-fire housing suggest that social vulnerability was greater in areas with higher fire risk, and thus that household socioeconomics might also be predictive of where households relocated after the disaster.

Socioeconomic Drivers of Relocation Distance and Post-Relocation Fire Threats

Both household tenure (Figure 3.8) and pre-fire wealth levels (Figure 3.10) were correlated with relocation distance, suggesting that homeownership and wealth enabled residents to move farther from Paradise than their peers. In relation to homeownership, homeowners are more likely to receive a substantial insurance payout, and therefore have access to a broadened set of choices to relocate. Renters in the Paradise area stayed closer to home overall, despite a tight post-fire rental market (Chase & Hansen, 2021). Census data for nearby Chico, the top relocation destination outside of Paradise, reveals that the median monthly rent jumped from $1,044 in 2018 to $1,438 in 2022, perhaps in part due to influx of households who lost their homes in the Camp Fire. While rents in California as a whole also increased during this time, partially as a result of the pandemic, Chico's increase of 37.7% is notably higher than the California average increase of 23.0% over the same period. According to our analysis, those with the wealth, income, and/or an insurance payout to relocate away from this price-shocked market appear to have done so.

Binary logistic modelling, while not strongly predictive overall, provided another approach for determining which household attributes predicted relocation and relocation distance. Housing tenure, measured as the number of years a household had lived at its address before 2018, was the only household factor that was significantly associated with remaining in or near the affected area across all statistical approaches (bivariate modelling and both binary logistic regression models). This is an unsurprising finding, as length of residence tends to be highly correlated with measures of place attachment (Dandy et al., 2019), which in turn predicts a desire to return across many hazard contexts (Greer et al., 2020; Paul et al., 2024). That said, length of residence

is an imperfect proxy for place attachment. This finding calls for a need to survey this population to better understand this relationship.

Householder age was another common predictor in this work. Households with older householders were both more likely to have relocated outside the fire perimeter, and among all households which relocated, to have relocated farther away. This was a surprising finding, as the bulk of relocation literature would suggest that aging populations are more likely to remain and rebuild (Groen & Polivka, 2010; Paul et al., 2024). Age is an especially important factor in Paradise, which had a reputation as a retirement community before the fire. If older Paradise residents permanently resettle elsewhere, it portends significant changes in the community's social and economic structure. In 2018, 31.8% of the employed residents in Paradise worked in education, health care, or social assistance fields according to the American Community Survey; fields comprised in large part of elder-care activities. By 2022, that figure had dropped to just 24.3%, driven in part by the permanent closure of Feather River Hospital, which had been the only hospital facility on the Ridge until it was damaged in the fire (Jiang, 2023). The hospital closure itself may prove to be another factor that prevents older residents from considering a return, which can have ripple effects throughout the economy; other rural hospital closures have been associated with decreases in population and labor forces throughout the United States (Malone et al., 2022).

Associations between household characteristics and post-relocation hazards also prompt questions about continued exposure to climate hazards and climate gentrification in a wildfire context. "Climate gentrification" refers to the notion that climate change can deepen existing divides in hazard exposure across socioeconomic lines in a manner consistent with the framing of traditional neighborhood gentrification. Climate gentrification has been suggested in the

contexts of sea level rise (Keenan et al., 2018), changing fluvial flood risk (Miller & Pinter, 2022) and more recently with wildfire risk (Greenberg, 2021). This research shows that low pre-fire household value was associated with relocating into another high wildfire threat area in the immediate wake of a wildfire disaster. Unfortunately, the ramifications of this relocation are already occurring. In the 2024 Park Fire, some Camp Fire survivors lost their home for a second time after relocating to nearby wildland areas (Toohey, 2024).

Wildfire risks continue to rise due to the convergence of land use policies that promote building in wildland areas (Modaresi Rad et al., 2023; Radeloff et al., 2018), poor forest management and the culminating effects of wildfire suppression (Schwartz & Syphard, 2021), and climate change (Williams et al., 2019). Wildfire in California has historically been framed as an issue affecting relatively wealthy homeowners who choose to live in wildland-urban interface and intermix communities (Davis, 1995), who are presumed to have the resources and desire to return and rebuild after disasters. However, this analysis shows that this is not the case for the typical Camp Fire survivor. Here, the determinants of displacement track more closely with patterns observed after Hurricane Katrina, where former residents not only become permanently displaced (Groen & Polivka, 2010; Vigdor, 2007), but often to areas with similar hazard risks (Myers et al., 2008). Where the experience of Camp Fire survivors varies from Hurricane Katrina is in the specific determinants of relocation and relocation distance. In Hurricane Katrina, as in many disasters, older residents were more likely to return; here, older residents were more likely to relocate and at greater distances. Race and wealth were both predictive of relocation after Hurricane Katrina; here, only wealth appears to influence relocation, and in the opposite direction (Groen & Polivka, 2010; Hu et al., 2019; Paul et al., 2024). Paradise and New Orleans are markedly different in their demographics, so some divergence in the social determinants of relocation is

not surprising. More work related to the social dimensions of wildfire recovery is needed to understand if the experience of Camp Fire survivors is singular, or if other wildland communities throughout the American West will experience similar social effects on relocation in the wake of inevitable future fires.

Limitations and Uncertainties

There are limitations and uncertainties in using consumer and/or credit data to analyze any type of migration, limitations within the non-spatial attributes of the consumer database itself, and uncertainties regarding modelled fire threat.

First, the use of consumer databases to understand population relocations has inherent limitations and will exclude certain populations including those with little or no financial footprints (DeWaard et al., 2020). Our dataset was not a 100% sample of all households in Paradise; instead, only approximately half of all pre-fire households were matched to a pre-fire and post-fire address in the DataAxle database. While comparisons to available Census data in Table 2 showed that the data in our sample was similar to pre-fire Paradise and Magalia overall, our sample still over-represented smaller, wealthier households. Further, these databases are known to miss many relocation events, especially if displaced residents live with other family members or otherwise migrate in a way that doesn't leave a footprint of financial data such as establishing a utility account at a new address. Therefore, it is likely that our sample broadly overestimates the number of households which remained in Paradise. This is borne out by examining Census data: Paradise's population at the 2020 Census was estimated at just 4,764 people, while our analysis suggests that a similar amount of households remained in the Town limits. This is highly

unlikely given average household sizes of 2 or greater. While reconstruction continues, the pace of construction has remained slow, so it is unlikely that many new housing units were constructed by the time of our post-fire 2022 snapshot of addresses (Siegler, 2023). Therefore, the most likely explanation is that many families may be receiving mail or holding accounts at addresses without a livable structure; or may not have opened a new account at a different address even though they are truly living outside the burned area.

An additional limitation was the absence of non-spatial attribute information for all households in our sample. For instance, the sample lacked information about income or education levels, and only included imperfect proxies of wealth in the form of DataAxle's proprietary WealthScore and median home values. This data also lacked reliable information about households' ethnic or racial identities, which have been shown in other disaster context to be highly correlated with post-disaster outcomes. While there were indicators for ethnicity and race in the dataset, upon further inspection they were inferred from the householder's last name, a problematic and flawed strategy for guessing at ethnicity and race. For this reason, race and ethnicity were omitted as potential predictors in this analysis. Lastly, a significant number (nearly 20%) of records lacked information on householder age, or had incomplete address information; therefore those records were omitted for analyses including age or detailed spatial location – including assigning wildfire threat. The lack of consistent non-spatial attribute information for all records in this secondary dataset suggests a need for primary data collection among households affected by the Camp Fire.

Finally, the use of CalFire's fire threat model excludes analysis of households that left California. The model's 2019 vintage may underestimate the fire threat for areas that had just burned in the prior year – including the Camp Fire burn scar. Since the model is based in part on

remotely-sensed vegetation information, recently burned areas like the Camp Fire area were likely classified into lower threat categories than they would be after more years of vegetation regrowth. Nevertheless, the spatial precision of this model, coupled with its widespread public availability and use, warranted its use over other potential alternate models.

Conclusions

This study analyzed the wide dispersion – or "diaspora" – of Camp Fire-affected households across California and the US. It also revealed that many relocated households continue to inhabit areas with high wildfire severity, and that household-level socioeconomic attributes affect whether fire survivors relocated, how far away they moved, and their likelihood to be exposed to future wildfire threats. Key takeaways include that over half of those displaced by the Camp Fire continue to live in communities with wildfire threat, including those still in and near the Camp Fire. Housing tenure and householder age both were significantly correlated with relocation and relocation distances. Households which had lived on the Ridge for longer were more likely to remain, but conversely, older residents were more likely on average to relocate farther away than their younger neighbors. This finding was counter to many other post-disaster analyses. Finally, this study established an empirical link between pre-fire housing value and post-fire wildfire risk; with those who relocated to very high fire severity areas having had the lowest pre-fire home values on average. This finding is consistent with the idea of climate gentrification, which has been used primarily in the context of flood hazards and sea-level rise. It also highlights a need for continued research into economic marginalization, housing affordability, and exposure to wildfire hazards in California and throughout the American West.

This work also showed that it is possible to visualize post-wildfire patterns using consumer databases. Such datasets, informed by credit bureaus and intended originally for marketing purposes, are imperfect but useful tools in visualizing migration. Such data can be used for public benefit, and we hope that data aggregator companies such as DataAxle continue to offer such data to academic researchers in the future.

Development in the wildland-urban interface continues unabated in California and throughout the American West, and wildfire risk has played little role in guiding urban development decisions in California even in the present era of large, destructive, climate-driven fires. As fire modelling and social vulnerability models suggest, there are many potential future Paradise-level disasters waiting to happen in our wildland-interface communities. Unfortunately, the lessons of Paradise will continue to be valuable to other communities which will face similar disaster displacement under contemporary land use, development, fire management, and climate change mitigation regimes.

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CHAPTER 4: To Stay or Not to Stay: Understanding Motivations Behind Observed and Stated Residential Preferences of Survivors of the 2018 Camp Fire

Abstract

This project shares results from a survey of more than 600 survivors of the 2018 Camp Fire in Paradise, California. The survey, conducted more than four years after the disaster event, aimed to better understand the factors associated with remaining and rebuilding in Paradise, versus relocating elsewhere in the long term. We find that housing tenure, type, and affordability; place attachment to Paradise and/or the Ridge; perceptions about future wildfire risk; and age and race all play a significant role in helping explain which households remain in Paradise and which remain long-term relocated. In a break from most previous literature regarding demographic factors that influence relocation, younger and non-white fire survivors in our survey were found to have greater odds of remaining or rebuilding within the fire footprint relative to their comparison groups. Among households which remain displaced, place attachment, neighborhood satisfaction, and notions of blame for the wildfire disaster are all predictive of stated desire to return to Paradise (or not).

The Camp Fire remains one of the deadliest and most destructive wildfires in American history. The findings of this survey are likely to aid those responding to and planning for communities with a similar susceptibility to wildfires. It may also aid in understanding how the populations at risk of similar climate-driven hazards may continue to change in the future as a result of risk perceptions and climate awareness.

Introduction

Background and Motivating Questions

On November 8, 2018, California's most destructive fire destroyed the town of Paradise and surrounding communities, destroying over 14,000 structures, killing 85 people, and displacing approximately 40,000 residents (Smith & Wigglesworth, 2023; Wallingford, 2018). Five years after the fire, Paradise's population remains at less than a third of its pre-fire level, with many former residents now seemingly rebuilding their lives elsewhere. Where have these residents gone, and how many of them might intend to return? How does their experience during the fire, their socioeconomic status, and their understanding of what caused the fire influence their desire to return to Paradise – or not? To explore these questions, surveys were sent to thousands of households that lived through the fire at their current addresses – whether they still live in Paradise or elsewhere in California or the nation.

This paper summarizes key findings from that survey, with a special focus on two research questions: first, what factors are associated with residents staying or rebuilding in Paradise, versus those that are now long-term relocated roughly five years after the fire? Second, what factors might be associated with long-term relocated residents' willingness to return to Paradise? More specifically, do their experiences before, during, and after the fire affect their interest in returning? What about who or what they might blame as contributing factors to the fire – does respondents' belief in climate change influence their willingness to return? If residents who identify climate change as a contributing factor to the fire are less likely to return, what does that mean for the future of vulnerability in each subsequent climate-driven disaster? In asking these questions, this project investigates both *revealed outcomes* in terms of the characteristics of

households which remained versus those that are long-term relocated, in addition to exploring *stated preferences* among long-term relocated households. Investigating these outcomes and preferences can not only help inform planners in Paradise and Butte County about these communities' futures, but can also help provide a framework for understanding displacement and relocation in future wildfire settings. With the confluence of climate change and decades of fire suppression and forest mismanagement, such community-level devastation is unfortunately likely to continue striking communities in California and throughout the American West.

While this is the first work to examine long-term relocation among survivors of the Camp Fire, and one of the first to examine relocation determinants in a wildfire setting, there is established interdisciplinary hazards literature related to understanding disaster displacement, long-term relocation, and the role that risk perceptions and place attachment play in the rebuilding or resettlement process. Much of this work has been applied to understanding the recovery from Hurricane Katrina, although a smaller subset of literature has examined place attachment in post-fire landscapes as well.

Disaster Displacement Literature

Historically, disaster recovery literature has traditionally focused on the recovery of physical infrastructure and buildings, to the exclusion of social factors that often help define recovery. Attention toward these social factors, including the role of social capital, place attachment, socioeconomic status, and risk perceptions, has been growing in recent decades; with many studies explicitly examining the question of social variation in who returns to a disaster-affected community versus populations that permanently resettle elsewhere (Paul et al., 2024). That said,

there is still a relatively narrow literature on long-term resettlement, with evacuations (short-term) and dislocations (medium-term) more often studied than long-term relocation or resettlement. While the bulk of work studying long-term relocation use the term "resettlement" to refer to those who remain outside the disaster footprint years after the event (Paul et al., 2024), this paper uses the term "long-term relocated" to describe this population, since many in this group would still like to return to the affected area and their current location is not necessarily where they would prefer to "settle."

Determinants of Displacement: Place Attachment and Demographics

Several recent works have focused on social factors that can influence a household's ability or desire to return to a disaster-affected area. Factors examined by these works can be broadly categorized into two groups: first, the role of social capital and notions of place attachment, and second, household socioeconomics and demographics. Alex Greer's study of place attachment's role in recovery after the 2013 tornado in Moore, OK (Greer et al., 2020) is a good example of a work in this first group. Greer and his team collected more than 700 surveys from households who lived within the tornado's path. The survey captured metrics of place attachment through survey questions asking respondents to agree with statements such as "I feel my community is a part of me" and "I trust people in my community." They found that respondents with a greater sense of place attachment often downplayed or minimized the threat posed by tornados. Those with a lesser sense of place attachment, unsurprisingly, were more willing to consider relocating to another community during the post-disaster period. Greer's discussion includes a call to researchers to study these phenomena in other hazard settings (Greer et al., 2020).

A broader set of literature focuses on the role that household composition and socioeconomics plays in influencing a household's ability or desire to return after a disaster. The use of Census data to inform disaster vulnerability is one of the core tenets of the interdisciplinary natural hazards research field (Cutter, 1996). Therefore it is no surprise that Census information, often augmented by survey information on similar characteristics, is commonly applied to questions of disaster recovery or resettlement. Several findings appear common to multiple hazard types and settings, including the unique role often played by age, race, income, and homeownership.

Across disaster types, age is often found to be positively correlated with remaining or rebuilding after a disaster. Two studies of displacement after Hurricane Katrina found that older residents were more likely to remain in New Orleans (Groen & Polivka, 2010; Hu et al., 2019), with an additional study of multiple tornado events in the Southeastern US also finding a higher propensity for elders to remain and rebuild (Cong et al., 2018). With a demographic that is older than the state's average, and existing work highlighting the specific vulnerability of elders (Chase & Hansen, 2021), it follows that age might be a powerful predictor of long-term relocation from Paradise.

Examination of the role that race and ethnicity plays in disaster recovery is often less consistent than the effect of age (Paul et al., 2024). A post-Katrina paper found that while Black residents were overall less likely to return to New Orleans, the effect of race became insignificant when controlling for damage – in other words, Black residents had been more likely to live in neighborhoods like New Orleans' Lower Ninth Ward that saw the most damage during the storm (Fussell et al., 2010). Other work found that the differential between rates of white and Black residents returning diminished with time post-Katrina, with the effect minimal more than four years after the disaster (Groen & Polivka, 2010). Other researchers have highlighted the specific

hurdles experienced by non-white and immigrant populations in the wildfire recovery context, with the specific needs of low income immigrant populations often overlooked in wildfires affecting predominantly wealth communities (Méndez et al., 2020). Race and ethnicity are far from the only dimension of identity that can affect the disaster recovery experience; queer populations often face aspects of discrimination that can hamper their access to resources and recovery programs post-disaster, though this remains understudied (Goldsmith et al., 2021)

Poverty has long been understood as a primary dimension of disaster recovery (Fothergill & Peek, 2004), especially in regards to the ability to secure temporary housing during the post-disaster period (Peacock et al., 2018). Related to poverty is the aspect of homeownership versus renting: renters have been observed to consistently face greater obstacles in returning after a disaster for a myriad of reasons. These can include greater place attachment among homeowners, the impact of homeowner's insurance, and perhaps the tethering role played by a mortgage. Conversely, renters often face limited choices, threats of eviction from landlords who may have also lost housing in the disaster, and price-gouging in nearby communities (Paul et al., 2024).

Data-driven simulation models of disaster recovery have also attempted to use such socioeconomic data, with Burton's 2019 earthquake recovery model for the Los Angeles Basin heavily relying on Census information to predict which neighborhoods might recover faster than others (Burton et al., 2019). Costa's team subsequently added in measures of place attachment, rooted also in correlations with Census data, into their own team's simulation of recovery from a theoretical earthquake event in the San Francisco Bay area (Costa et al., 2022). While such models are of limited immediate value in understanding dynamics in Paradise as they are only theoretical in nature and address a different hazard, the use of such socioeconomic variables in

predicting neighborhood-level return suggests that these socioeconomic indicators are important to consider across many disaster contexts.

Willingness or Desire to Return after a Disaster

The specific question of willingness or desire to return to the affected area among residents who are still long-term relocated away from the region remains relatively unaddressed in the literature. Morrice (2013) interrogated this question by conducting semi-structured interviews among former New Orleans residents living in Houston after Hurricane Katrina, finding an overall sense of heartbreak and desire to return among displaced residents, but the limited number of interviews (16) in her study precludes generalization to the entire displaced population. Another recent study taking a more quantitative approach to this question was recently completed in Sichuan Province in the wake of China's Wenchuan and Lushan earthquakes, occurring in 2008 and 2013, respectively (Xu et al., 2020). While this study did have a higher number of respondents (327) and revealed strong links between various place attachment metrics and willingness to return after an earthquake, the vastly different political, cultural, and hazard type setting make this study's results not very transferrable to understanding wildfire in the American West. There is a clear gap in the literature regarding understanding the residential preferences and return intention of disaster displaced populations in post-wildfire settings in North America.

The limited amount of wildfire-specific work on this topic largely concerns the role that place attachment plays in risk perception and willingness to conduct wildfire mitigation activities, with the bulk of this research drawn from household surveys across the American and Canadian West. McGee's work in Alberta involved semi-structured interviews with 40 homeowners one year out

from devastating wildfires; concluding that the experience of living through the wildfire did not appreciably influence respondent's perceived risk of fire of willingness to adopt mitigation activities (McGee et al., 2009). Similarly, a more recent study of Colorado residents in Boulder and Larimer counties came to the same conclusion. While firsthand experience with wildfire did not appear to move the needle much on risk perceptions and mitigation activities, Champ and Brenkert-Smith (2016) found that it was actually "learning from neighbors or recognizing how wildfire spreads across property lines" that correlated more strongly with accurate risk perceptions. In a separate study of wildfire survivors in Boulder County, Mockrin found that residents who had just lived through a wildfire were almost universally willing to return. Residents mentioned environmental amenities and place attachment themes in their desire to return, in addition to what Mockrin termed a "gambler's fallacy" effect – the belief that the odds of a second fire would be low since they had just experienced one (Mockrin et al., 2015). It is worth noting that as I write this in 2024, many portions of Paradise and surrounding communities are currently under evacuation warnings from the Park Fire, not even six years after the Camp Fire disaster. Lastly, one study, again on Colorado homeowners, did specifically test the effect of climate change knowledge on households' willingness to adopt wildfire mitigation activities, finding that survey respondents who were provided with information about climate change were more likely to state a willingness to pursue mitigation efforts (Schulte & Miller, 2010).

Place Attachment in Paradise and the Ridge Communities

As a resident of Paradise during most of my childhood and a graduate of Paradise High School, much of my own family and social network is deeply rooted in Paradise and surrounding Ridge communities. Paradise held an identity, before the fire, as a lower-middle income retirement

community with little racial diversity and many residents disabled or living on fixed incomes. This is borne out in Census ACS data for the pre-fire period, which shows Paradise as having a median age of 49.1 (compared to 36.3 for the State of California) with 25.8% of its residents over the age of 65 compared to just 12.1 percent in the rest of the state. The median income in 2018 was just $49,270 compared to a statewide median income of $71,228, and 90.5 percent of residents identified as white alone, compared to just 60.1 percent of all Californians.

My own lived experience provides ample evidence of the place attachment that many residents have or had to Paradise and the surrounding "Ridge Communities," which I define generally the areas between Butte Creek and the Feather River including Magalia, Paradise Pines, Stirling City, Yankee Hill, and Concow. That said, a small amount of published work has also directly touched on these themes in the post-disaster period among these communities.

Interviews conducted by a sociologist in the months following the fire revealed a profound loss of sense of place as interpreted through environmental markers (Brown, 2022). The Camp Fire so thoroughly ravaged the once forested landscape and destroyed so many buildings that roads and landmarks did not look familiar to many longtime residents, who described disorientation and the loss of meaning amidst the physical and social changes in the community. As a former resident, I can describe the exact same reaction described in Brown's work upon my first visit back to Paradise with my family in the weeks after the fire to visit our destroyed property. That much of Brown's work focused on a perceived loss of place attachment suggests that pre-fire Paradise was a place that held a great amount of place attachment for many residents. For many residents who were displaced, social media became the sole link to their former networks in Paradise and surrounding communities (Benedict, 2022).

Evidence of place attachment can also be seen in the numerous disaster commemorations held and sites created since the Camp Fire, including the burial of a time capsule on the 5th anniversary of the fire (Gutierrez, 2023) and the construction of a "rising phoenix" sculpture fashioned out of keys of homes destroyed in the fire (Elasaar, 2019), among other community commemorations and events. These acts can be seen under the frame of recent work on disaster commemorations as activities that reinforce place attachment and bring together former residents, even those who remain long-term relocated (Zavar & Schumann, 2019).

Methods

Mapping the Ridge Diaspora

Survey data collection in this project rests on earlier work conducted in 2023 which found current addresses for former residents of Paradise and the surrounding Ridge communities (Miller and Pinter, 2024). We used change-of-address data provided by a consumer data broker to trace current address for any household which had been located within the Camp Fire footprint as of November 2018. Chase and Hansen (2021) performed a similar study of households one year after the Camp Fire using similar data; our work in 2023 is in many ways a temporal extension of this earlier work. The use of consumer change-of-address data to visualize post-disaster relocation and displacement is growing in popularity, as it is one of few methods available that can visualize relocation on a disaggregated level (DeWaard et al., 2020).

This mapping work revealed 2022 residential locations for 8,112 households who had lived in the Camp Fire perimeter at the time of the wildfire. Households that experienced displacement were found in 43 states at a median distance of 36 miles (and a mean distance of 251 miles) from

the Camp Fire perimeter. Those who owned their homes pre-fire were found to be living more than twice as far, on average, as those who rented before the fire. Wealthier households were also found to be living farther, on average, from the fire perimeter than less wealthy households. Many households were also found to have relocated to other California regions with significant wildfire risk; with lower pre-fire home values predictive of a current address in the "very high" fire severity zone as determined by CalFire. Of these 8,112 households, 6,721 were found to have valid, mailable address information, which became our initial survey universe.

The 2023 Ridge Communities Survey: Learning from Past and Present Residents

Our team prepared an online survey in Qualtrics, designed to take approximately 10-15 minutes depending on the respondent's experiences before and after the Camp Fire. The survey was designed with abundant branching logic to account for the specific experiences of those who relocated and/or were displaced due to the fire, those who remained and/or rebuilt, and even newcomers to the Ridge who moved there after the 2018 fire. The survey asked about respondents' housing and quality of life, jobs and commute, and opinions about risk and responsible parties for the wildfire disaster, among other questions. This survey was designed to answer multiple research questions including examining housing affordability and commute impacts, changes in quality of life and neighborhood satisfaction, the desire to return to Paradise among those who relocated, and beliefs about the proximate causes of the wildfire disaster. The survey was pretested in January and February 2023 by friends, family, and community members who lived in Paradise at the time of the fire.

In early March 2023, survey recruitment announcements were mailed out to 6,721 households with a valid address across the United States who were observed to have lived in the Camp Fire footprint in 2018. All protocols of the survey were reviewed and approved by the University of California, Davis Institutional Review Board prior to any recruitment or data collection (1958929-1). Consent was obtained prior to taking the online survey, in accordance with the IRB. Survey announcements were not individualized to maintain anonymity, so survey data cannot be tied to household-level information obtained in our earlier study, but the survey asked for ZIP codes to approximate household locations. The survey announcements contained a brief explanation of the research objectives, researcher biographies for myself and fellow PhD candidate Mitch Snyder, and a shortened link to the online version of our survey in Qualtrics. Participants were also encouraged to contact us by phone if they did not have internet access or were not comfortable completing the survey online.

In addition to mail-based survey recruitment, we also recruited additional participants via social media, community bulletin boards, and in-person distribution of the survey announcement letter sent out in the mail. As a native of Paradise and graduate of Paradise High School, I shared our survey announcement in a Facebook group initially created for my 10-year reunion, which had taken place in summer 2018 before the fire and had stayed active through the fire recovery. We also shared the survey with other Facebook groups for Camp Fire survivors, and received help from fire-affected friends and family in recruiting additional participants using the snowball method. We also made several trips to the region in early 2023 and left survey announcements on community bulletin board in local coffee shops and grocery stores. Lastly, we purchased a booth at the 2023 annual Gold Nugget Festival, sharing results from our change-of-address work and recruiting additional participants by handing out announcements in person.

The online Qualtrics survey remained open from March to September 2023. The bulk of responses were collected in March and April coinciding with initial social media and mail recruitment, but we kept the survey window open as additional phone calls and those "snowball sampled" through friends and family continued to reach out through the summer. By the end of the survey collection period, we had received 711 total responses (partial or complete). This indicates a response rate of 10.6 percent when divided by the 6,721 households for which we obtained address data. Because some responses came through the additional recruiting methods, a precise response rate cannot be determined. Conservatively, the survey could be described as having a response rate of 4.5% when divided by all 15,781 potentially surveyable households who lived in the fire footprint in 2018. The full text of the survey, including the recruitment mailer sent to 6,721 households, can be found in Appendices B and A, respectively.

Figure 4.1 reflects the diversity of survey recruitment sources, with the majority (67.5%) of respondents recruited through the mail invitation. An additional 47 surveys were collected via direct solicitation by the author, primarily through personal contacts including family, friends, and former schoolmates. An additional 36 surveys were collected through posts on social media. Lastly, 134 surveys either indicated "other," or were collected with this question erroneously disabled. Many of these surveys are likely to be from the "online" or "sent by someone I know" categories, as this question was mistakenly withheld from the live Qualtrics survey until recruitment letters were distributed through the mail, but not before outreach had already begun. The "other/blank" category may also include survey participants that were recruited in person at our booth at the 2023 Gold Nugget Fair in Paradise.

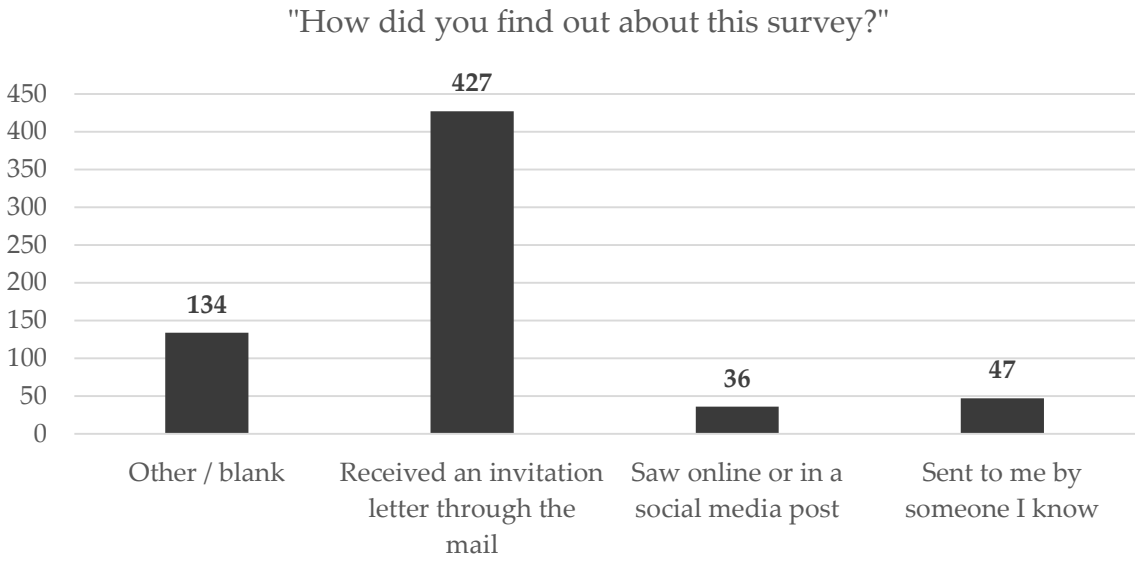

Figure 4.1. Distribution of survey recruitment methods. Some early surveys were erroneously administered without this question – these are likely to be "social media" or "someone I know" but are captured in "other/blank".

To ensure an adequate response rate across geography; the distance from Paradise to each survey participant's ZIP code was compared to the distribution of distances in the DataAxle household relocation data described in Chapter 2 of this dissertation (Figure 4.2). This visualization shows that our survey achieved a response rate of over 10 percent in each of seven "distance bins," with significantly higher response rates in the first two bins (Less than 10 miles, and 10 to 24.9 miles). Some of this apparent high response rate in the first two distance bins is likely due to our supplementary survey recruitment methods of in-person recruitment, direct recruitment, and social media posts, which are all biased toward those remaining close to Paradise. It is also worth noting that the DataAxle household relocation data likely underestimates the true number of relocated households, and is likely to have better captured households which moved farther from Paradise; therefore, these high apparent response rates may in fact be inflated.

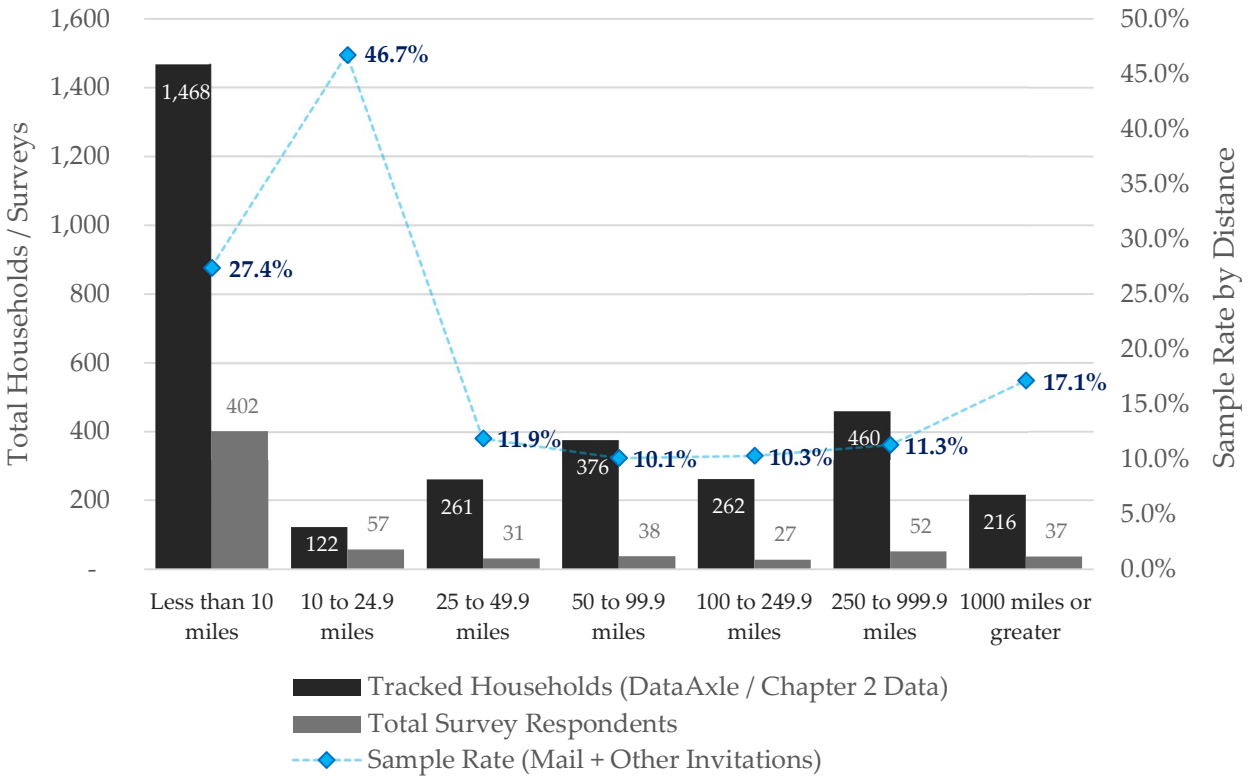

Figure 4.2. Survey sample rate by distance to Paradise

The survey also captured a representative cross-section of household experiences during the fire, with the vast majority of survey respondents losing their home entirely, and small minorities reporting only partial damage to their residence or reporting no damage whatsoever (Figure 3). This tracks roughly with CalFire's own damage assessment, which indicated that large majorities of structures inside the burn area were completely destroyed (Wallingford, 2018).

Data Cleaning and Regression Techniques

After the closure of the survey window, we systematically reviewed our survey data and dropped responses for which the majority of the survey was not complete, and we additionally re-coded

some responses to maintain data integrity (ie. numbers entered as text). From a total of 711 collected surveys, 644 contained complete responses to the potential dependent variables, and thus warranted consideration in this project's two models. A series of binary variables were created from ordinal survey responses in order to support logistic regressions akin to the techniques used by Landry et al. (2007).

Regression 1 predicts whether or not respondents who lived on the Ridge in 2018 remained on the Ridge as of 2023, according to respondents' reported locations. The independent variable "Remained" was predicted as a function of matrices of variables related to housing and tenure characteristics (H), reasons respondent indicated for living on the Ridge pre-fire (R), perceptions and preferences related to risk and housing (P), blame for the wildfire disaster (B), and finally respondent identities including age, race, and gender (I).

Regression 1: Predicting Respondents Who Remained

$$\text{Remained} = \beta_0 + \beta_1 H + \beta_2 R + \beta_3 P + \beta_4 B + \beta_5 I + \varepsilon$$

Regression 2 attempted to predict relocated residents' stated desire to return to Paradise "under ideal circumstances." In Regression 2, the binary variable MoveBackYM ("1" for relocated respondents who indicated "yes" or "maybe" they would relocate to Paradise under ideal circumstances, "0" for relocated respondents who indicated "no") is predicted as a vector of the same survey variables in Regression 1, plus an additional vector (C) that is relevant only to the relocated group: the difference in satisfaction between various aspects of their current community as compared to their pre-fire community in Paradise and/or the Ridge. This

regression is only run on the 241 households which indicated they remained displaced from the Ridge as of 2018.

Regression 2: Predicting Respondents' Desire to Return

$$\text{MoveBackYM} = \beta_0 + \beta_1 H + \beta_2 R + \beta_3 C + \beta_4 P + \beta_5 B + \beta_6 I + \varepsilon$$

Potential predictors in each motivation subgroup (34 predictors for Regression 1 and 47 predictors for Regression 2) were systematically selected for inclusion in each logistic regression using Hosmer and Lemeshow's "purposeful selection process" for logistic regression, summarized by Bursac et al. (2008). In brief, predictors with initial p-values under .25 are used to construct an initial model. Next, any predictors in this initial model that are both not significant (at a p value of .1) and not collinear with other predictors (measured by a shift in other predictors' coefficients greater than 20%) are iteratively removed from the initial model. Lastly, all unselected predictors are tested one last time for inclusion in this refitted model if they are significant predictors or collinear with other predictors using the same $p > .1$ and 20% cutoffs used for initial model construction. The final models using this purposeful selection process included 12 predictors in Regression 1, and 6 predictors in Regression 2.

Results

Survey Summary Statistics and Willingness to Move Back

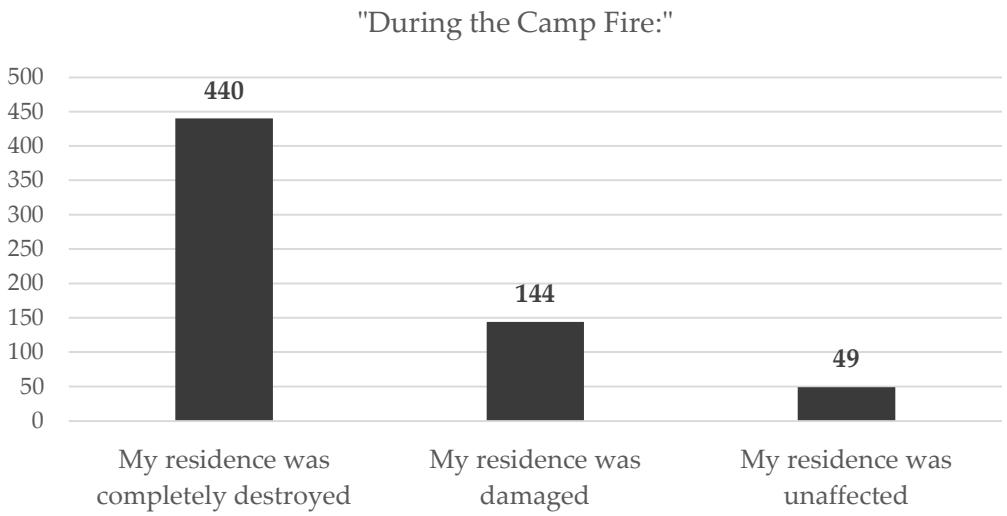

Figure 4.3. The Camp Fire's impact on survey respondents' residences

Of the 623 participants who completed the survey, nearly 60 percent (371 respondents) lived in Paradise as of the survey period. This is notable given that a large majority of all groups reported that their residence had been completely destroyed in the wildfire; indicating that many in the "remain in Paradise" group temporarily relocated between the two time periods asked about in the survey – 2018 and 2023. For the 241 respondents who lived outside of Paradise, participants were asked to indicate whether they would return to their pre-fire community "under ideal circumstances," with possible answer choices of yes, maybe, and no. Within this relocated group, 87 respondents (36.1 percent) responded "yes," 55 respondents (22.8 percent) responded "maybe," and 99 respondents (41.1 percent) responded "no." An additional 11 survey respondents were newcomers to Paradise who had relocated to the community in the years since the 2018 wildfire. While this group was given a separate set of questions pertaining to what attracted them to the area, their small number did not warrant further analysis as part of this project.

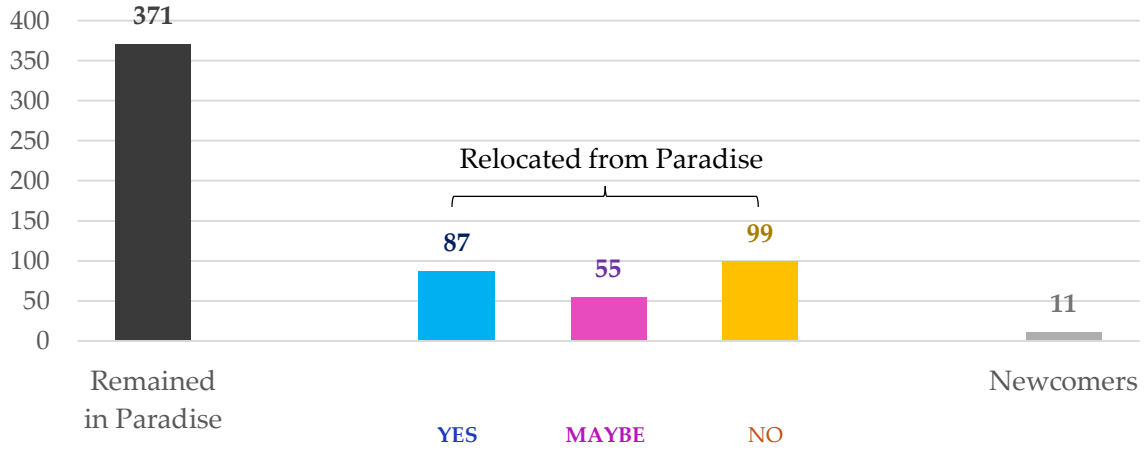

Figure 4.4. Distribution of respondents by displacement category and willingness to return "under ideal circumstances."

The reported residence of those 241 survey participants who relocated from Paradise is visualized in Figure 4.5, color-coded according to their response to the question about a hypothetical return to Paradise. The distance that respondents moved from Paradise indicates a long right-tailed distribution, with a mean distance of 330 miles, a median of 58 miles, and a maximum distance of 2,446 miles, representing a survey participant who had relocated to Kona, HI. Other notable outliers include participants who had relocated to locations like Fredericksburg, VA (2,341 miles); New Bern, NC (2,429 miles); Winter Haven, FL (2,399 miles); and Yakutat, AK (1,582 miles). That said, the median distance of 67 miles is more reflective of a dense distribution of Sacramento Valley and/or foothill locations near to the fire footprint. In terms of regional distribution, 80 respondents (33.2%) still lived in Butte County outside the fire footprint, 25 respondents (10.4%) lived in other Sacramento Valley counties, 53 respondents (22%) lived elsewhere in California, and 83 respondents (34.4%) lived outside of

California. Beyond the Paradise and Magalia ZIP codes, the next most common ZIP codes for survey respondents were 95973 (North Chico – 27 respondents), 95926 (Central Chico) and 95928 (South Chico) with 14 respondents each, and 95965 (Oroville – 7 respondents).

Figure 4.5. Map of Relocated Survey Respondents. Dots are randomly assigned inside survey participants' reported ZIP codes and thus do not reflect exact locations.

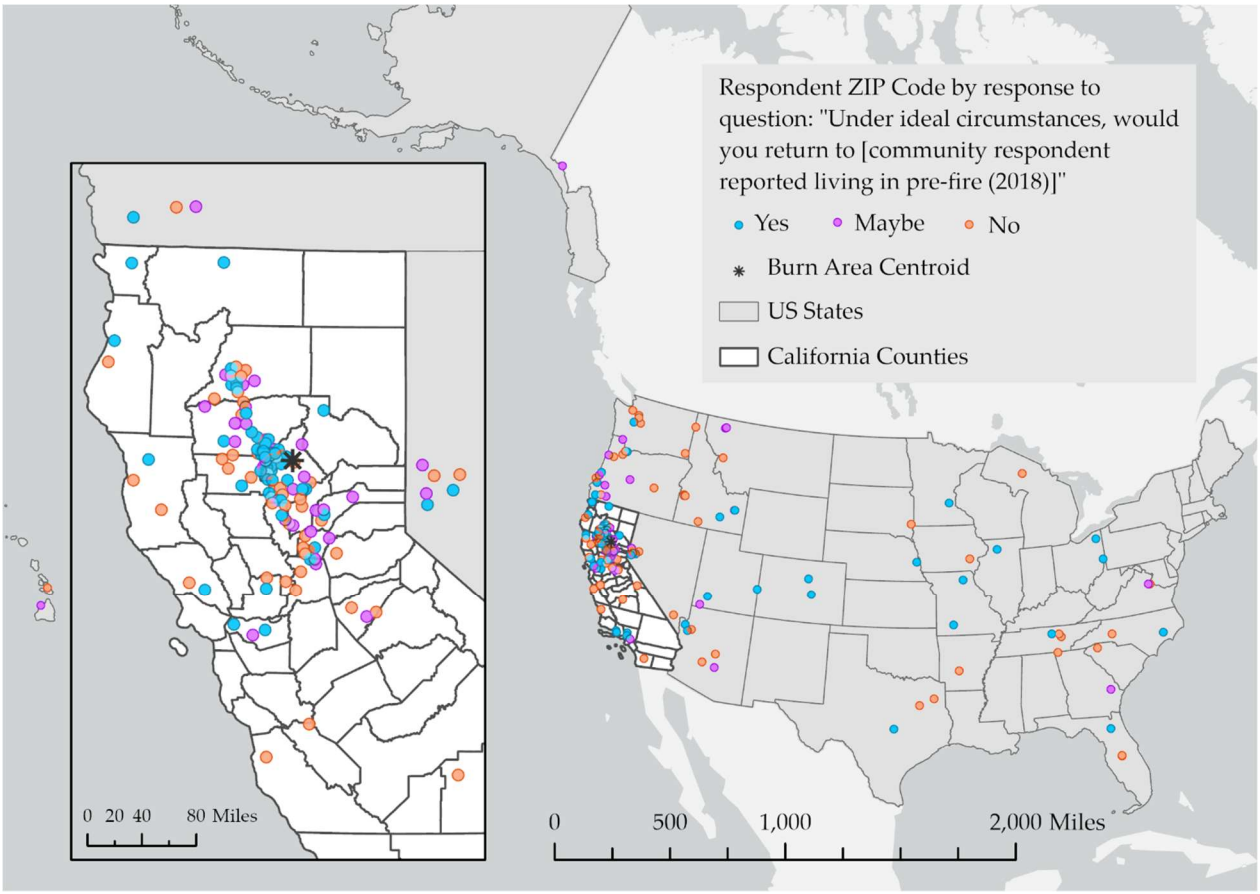

Table 4.1 summarizes some of the key background characteristics of the survey universe broken out into the various relocation and willingness to return groups that are used as dependent variables throughout the remainder of this project.

Table 4.1. Selected Household Characteristics by Relocation and Willingness to Return

Characteristic	Total (n = 612)	Remained (n = 371)	Relocated (n = 241)	Relocated *[Yes]* (n = 87)	Relocated [*Maybe]* (n = 55)	Relocated [*No]* (n = 99)
% Home Completely Destroyed	68.6%	58.5%	85.1%	83.9%	92.7%	81.8%
% Owned Their Home Pre-Fire	82.8%	80.9%	86.3%	75.9%	90.9%	92.9%
% Owned Their Home Post-Fire	83.9%	84.9%	83.0%	72.4%	85.5%	90.9%
% Housing Burdened* Pre-Fire	26.8%	26.4%	27.8%	29.9%	30.9%	24.2%
% Housing Burdened* Post-Fire	29.6%	32.9%	24.9%	37.9%	16.4%	18.2%
Average Age at Time of Survey	61.5	59.1	65.1	62.6	65.2	67.3
% Under 40 at Time of Survey	11.4%	14.0%	7.5%	10.3%	7.3%	5.1%
% Over 65 at Time of Survey	48.9%	43.1%	58.5%	47.1%	61.8%	66.7%
% With a Bachelor's Degree	45.0%	44.2%	46.5%	40.2%	56.4%	46.5%
% Identifying as Non-White**	14.1%	17.3%	8.7%	9.2%	3.6%	11.1%
Average Distance from Paradise	174.2	--	411.1	437.7	278.9	461.3
% Still Living Within 50 miles	76.1%	100%	41.9%	47.1%	50.9%	32.3%

*defined as spending 30% or more of household income on housing (mortgage or rent)
**includes all respondents who indicated at least one racial or ethnic identity other than white

Not surprisingly, respondents who remained in Paradise were much less likely than those who relocated to have had their homes completely destroyed during the fire. Rates of pre-fire homeownership were actually somewhat higher in the relocated group, although the relocated group experienced a drop in homeownership rate between 2018 and 2022, whereas those who remained in Paradise were more likely to own their homes in 2022 compared to 2018. The pre-fire homeownership rate for all survey respondents (82.8%) was somewhat higher than Paradise's overall pre-fire homeownership rate at 70.0% as indicated in the 2018 ACS.

The survey did not ask respondents directly about income but asked about the percentage of income spent on housing as a proxy for financial well-being. Before the fire, just over a quarter (26.8%) of respondents reported spending more than 30% of their income on housing, which is

somewhat lower than the 2018 ACS figure for Paradise of 37.3% of households falling into this category. Among the remain group, this figure rose from 26.4% 32.9% after the fire, while among the relocated group, the figure actually fell from 27.8% to 24.9%. This may speak to the increase in housing prices in Butte County caused in part by the fire itself, contrasted with many in the relocated group moving to lower-cost destinations outside California.

Survey respondents skewed older overall, with an average respondent age of 61.5 - somewhat higher than Paradise's pre-fire median age of 49.1 (2018 ACS). To some extent, this can be explained by minors being outside the survey universe, but some of the age discrepancy is likely a result of older households being more likely to be sent a survey due to the manner in which the survey universe was defined and/or higher survey completion rates among older populations. Interestingly, the relocated group is six years older (65.1), on average, than the group that remained (59.1). Within the relocated group, those who are willing to move back are nearly five years younger on average (62.6) than those who are not interested at all in returning (67.3).

Average educational attainment rates were similar between the relocated and remain group, but racial identity showed a market split, with 17.3% of those remaining identifying a racial identity other than white, versus only 8.7% of those in the relocated group identifying as such. In both cases, the survey sample deviated somewhat from Census data for the pre-fire period. In terms of educational attainment, 45% of all survey respondents held at least a Bachelor's degree compared with only 21.7% of Paradise residents overall, and 14.1% of the survey sample indicated a racial identity other than white alone, compared to just 9.5% reporting a racial identity other than white alone in the 2018 ACS.

Within the relocated group, average distance from Paradise appears to correlate somewhat with desire to return, with over 47% of those indicating a desire to move back reporting a residence

within 50 miles of Paradise, versus just 32.3% of those stating no interest in returning living within a 50-mile radius. For interpreting distances from Paradise, the boxplot in Figure 4.6 below may be more helpful than the numbers in Table 4.1, as the extremely long-tailed distributions of distance from Paradise make medians more important than means for this metric. While the median respondent overall lives 58 miles from Paradise, there is some variation between willingness to return categories. Respondents indicating "yes" they would return live at a median distance of 41.1 miles from Paradise (with a standard deviation of 539 miles), those indicating "maybe" live at a median distance of 44.6 miles from Paradise (with a standard deviation of 592.0 miles), and those who indicated "no" they would not return live at a median distance of 81.9 from Paradise (with a standard deviation of 674 miles). This suggests that the farther away respondents have relocated, the less likely they are to entertain a potential scenario that involves relocating back to Paradise, while the "yes" and "maybe" groups are more similar (Figure 4.6).

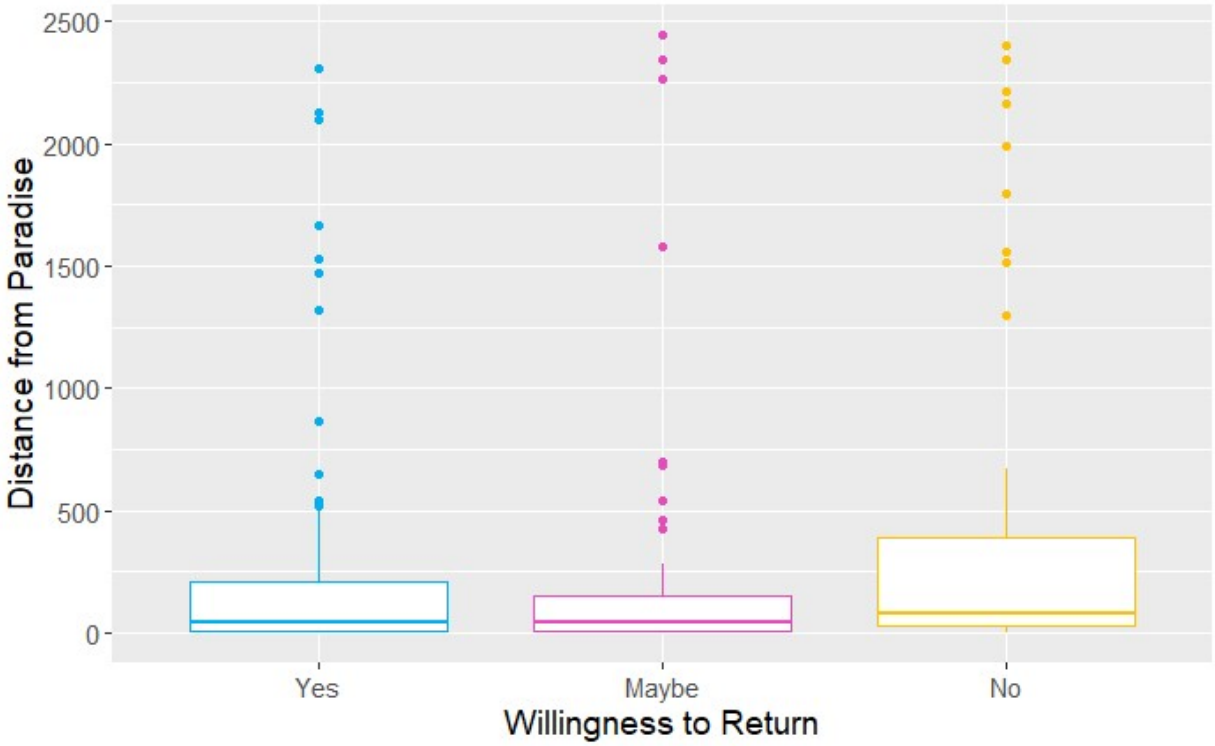

Figure 4.6. Distribution of distance from Paradise by relocated respondents' reported willingness to return to Paradise.

Beliefs about the Fire and Climate Change Crosstabulations

A variable of interest in potentially explaining observed and preferred residential preferences is respondents' beliefs about who are what were contributing factors to the wildfire disaster. Figure 7 summarizes responses to a matrix question that asked respondents to consider six factors for potential responsibility for the wildfire disaster. Each potential factor was evaluated independently, so respondents could deem any number of factors "somewhat" or "very" responsible for the wildfire disaster.

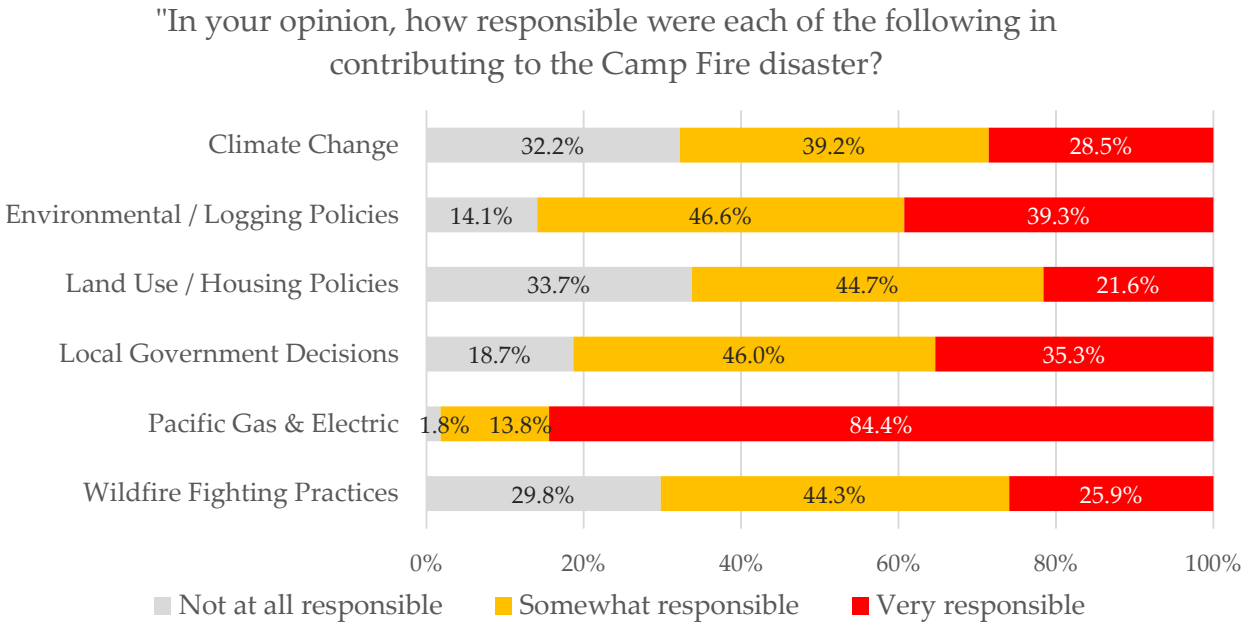

Figure 4.7. Summary of survey respondents' opinions about contributing factors to the disaster

Perhaps unsurprisingly, Pacific Gas and Electric (PG&E) was deemed very responsible for the disaster by a large majority (84.4%) of respondents, with only 1.8% of respondents deeming

PG&E not at all responsible. It is worth noting that PG&E was determined to be legally liable for damages incurred by the wildfire shortly before the survey went live in early 2023 (Solis, 2022). The next-most common responsible factor identified by respondents was "environmental / logging policies," with 39.9% of respondents deeming this factor very responsible and an additional 46.6% of respondents deeming it somewhat responsible. The next-most popular choice was "local government decisions," with 35.5% of respondents deeming this factor very responsible and an additional 46.0% considering it somewhat responsible. As will be discussed further in the next chapter, there are multiple possible interpretations of the meanings of each of these factors for particular survey respondents.

Respondents' belief in climate change as a responsible factor, a major motivating interest of this this project, was nearly evenly split across responsibility categories, with only 28.5% of respondents deeming it "very responsible," 39.2% of respondents considering it "somewhat responsible," and 32.2% of respondents considering it not at all responsible. The only factor that respondents believed more strongly was not at all responsible was "land use / housing policies" at 33.7%. Figures 4.8 through 4.10 further explore respondents' belief in climate change as a responsible factor for the fire as it related to gender identity, education level, current location, and willingness to return to Paradise.

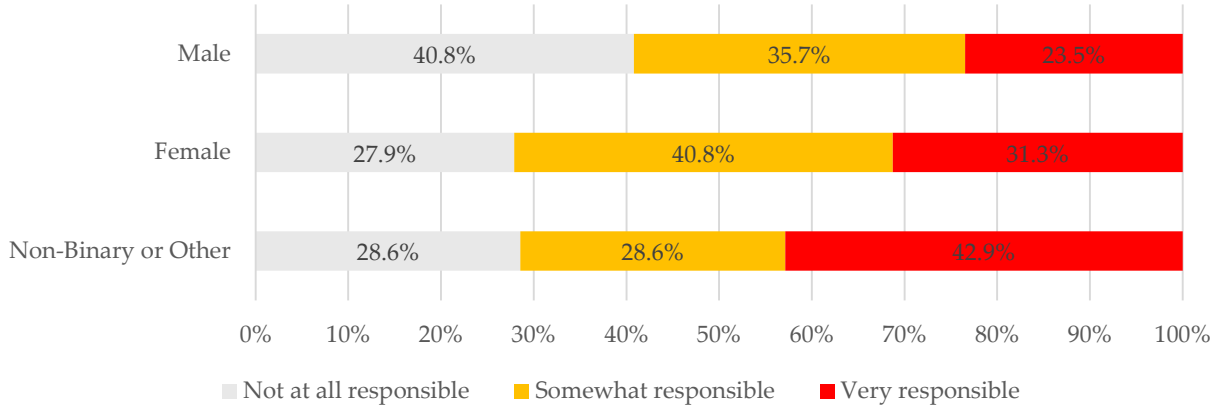

Figure 4.8. Crosstabulation between belief in climate change as a contributing factor for the fire and gender

There was a noticeable gender split identity regarding climate change's responsibility for the fire, with men considerably more likely to deem climate change "not at all responsible" (40.8%) than women (27.9%) or nonbinary individuals (28.6%). This crosstabulation is significant with over 99.9% confidence using a simple Chi-squared test between these categories.

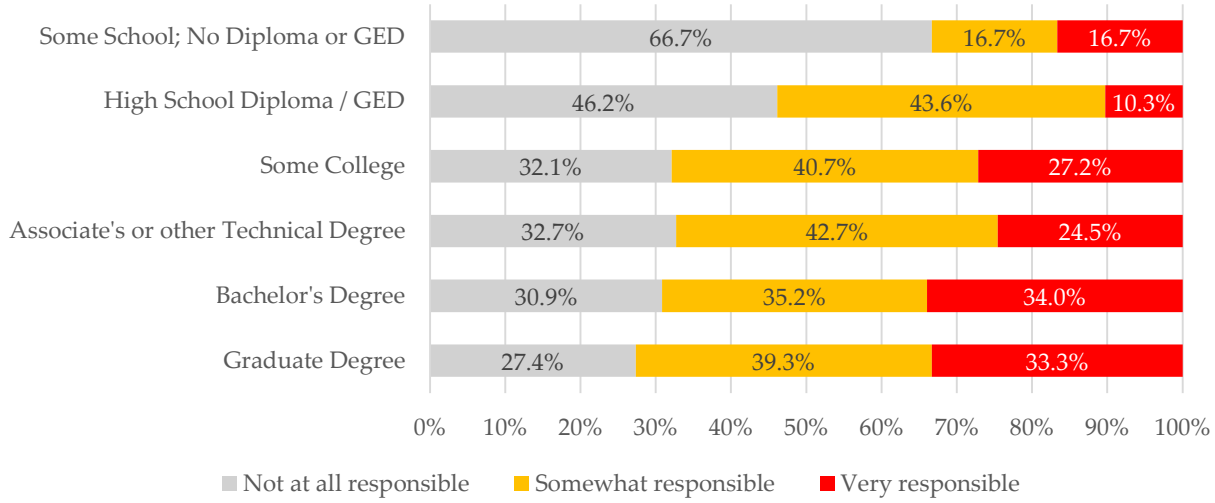

Figure 4.9. Crosstabulation between belief in climate change as a contributing factor for the fire and highest level of education obtained

Respondents' highest reported level of education was also a significant predictor of the level of blame attributed to climate change (99.9% confidence yielded by Chi-square test), with those with little to no college education showing markedly higher rates of finding climate change "not at all responsible." Among those with only a high school diploma, 46.2% of respondents deemed climate change not at all responsible, compared to only 30.9% of respondents with a bachelor's degree and 27.4% of respondents who completed graduate education. It is also worth noting that our respondents, as a group, skew more educated than the general population of pre-fire Paradise, with 45% of survey respondents holding at least a Bachelor's degree versus only 21.7% of Paradise's population as noted in the previous sub-section.

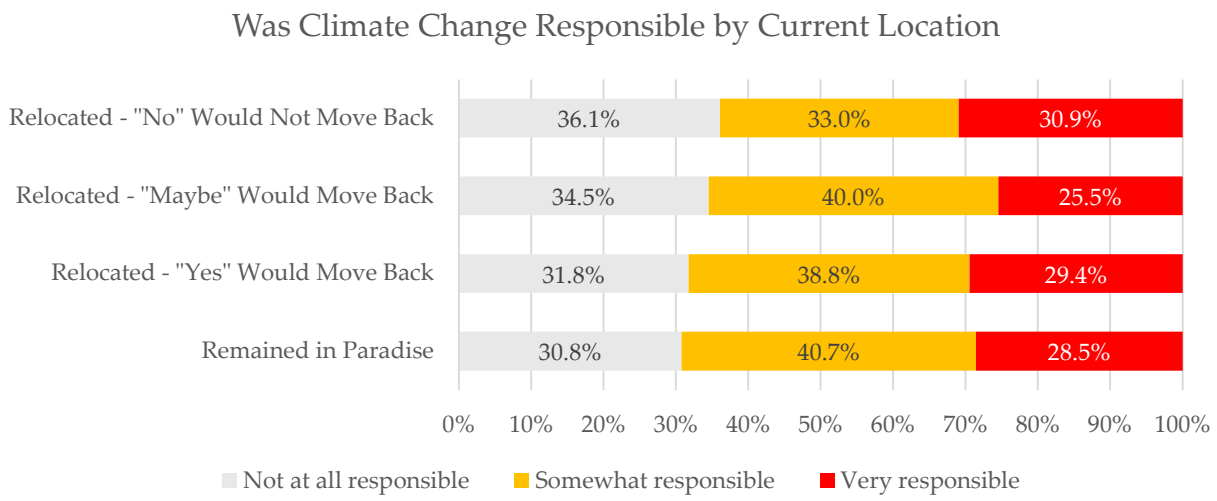

Figure 4.10. Crosstabulation between belief in climate change as a contributing factor for the fire and observed and stated residential preferences

There was also a significant association between respondents' observed (those who remained in Paradise versus those who relocated) and stated residential preferences (as measured by survey responses about hypothetically moving back) and holding climate change responsible for the fire. While this relationship is significant as measured by a Chi-squared test (at 99.9% confidence),

the proportions of respondents in each climate change belief category vary less between groups than in crosstabulations with gender or education.

Comparing Survivor Groups: Remained vs Relocated

This section focuses on finding significant determinants of whether or not a survey respondent remained in Paradise, or relocated as of the 2023 survey period. Table 4.2 summarizes each potential explanatory variable that might predict a respondent's likelihood of remaining in Paradise. Each of the 34 potential explanatory variables listed below were evaluated for potential significance in predicting the *RespondentRemained* variable, but only 12 were ultimately added to the final regression model summarized in Table 4.3. Most of these explanatory variables are also binary indicators, with the exception of *AgeCurrent* and *HouseholdSize*, measured in years and residents, respectively. Binary significance is indicated via a Chi-square test (or a T-test for the two numeric variables for age and household size) in the last column of the table, but this was not considered in fitting the regression model.

Table 4.2. Potential Predictors of Remaining vs. Relocating

Variable Type	Variable	Description	Remained (n = 371)	Relocated (n = 241)	Chi-Sq or T-Test P-value
Dependent	RespondentRemained	1 if respondent lived in the fire footprint in both 2018 and 2022	60.6%	39.4%	-
Housing and Tenure Characteristics	HouseDestroyed	1 if respondent indicated "my residence was completely destroyed"	58.5%	85.1%	<.001

	BeforeOwn	1 if respondent owned their residence in 2018	80.9%	86.3%	*not sig.*
	BeforeMobile	1 if respondent indicated their residence in 2018 was a mobile home	8.6%	14.9%	<.05
	BeforeMultifamily	1 if respondent indicated their residence in 2018 was in a multifamily building	3.0%	4.1%	*not sig.*
	BeforeHousingBurden	1 if respondent indicated they spent over 30% of their income on rent in 2018	26.4%	27.8%	*not sig.*
	AllAdultLife	1 if respondent indicated they had lived on the Ridge for 'most of all of [their] adult life'	48.8%	34.4%	<.001
Reasons Respondent Lived on the Ridge	BeforeReasonAfford	1 if the respondent indicated that 'affordability' was a reason they initially moved to the Ridge	26.1%	32.4%	*not sig.*
	BeforeReasonClimateEnv	1 if the respondent indicated that 'attractive climate / environment' was a reason they initially moved to the Ridge	31.0%	36.9%	*not sig.*
	BeforeReasonEmployment	1 if the respondent indicated that 'employment' was a reason they initially moved to the Ridge	8.1%	9.5%	*not sig.*
	BeforeReasonFamFriendly	1 if the respondent indicated that 'family-friendliness' was a reason they initially moved to the Ridge	16.2%	15.8%	*not sig.*
	BeforeReasonProximity	1 if the respondent indicated that 'proximity to family/friends' was a reason they initially moved to the Ridge	18.6%	22.4%	*not sig.*
	BeforeReasonNature	1 if the respondent indicated that 'proximity to nature / outdoor recreation'	25.9%	29.9%	*not sig.*

		was a reason they initially moved to the Ridge			
	BeforeReasonPrivacy	1 if the respondent indicated that 'privacy' was a reason they initially moved to the Ridge	15.4%	17.0%	*not sig.*
	BeforeReasonSchoolQual	1 if the respondent indicated that 'school quality' was a reason they initially moved to the Ridge	6.7%	3.7%	*not sig.*
	BeforeReasonSocialRel	1 if the respondent indicated that 'social or religious community' was a reason they initially moved to the Ridge	4.6%	7.1%	*not sig.*
Respondent Preferences and Perceptions	YardImportant	1 if the respondent agreed or strongly agreed with the statement 'having a house with a yard is important to me	90.0%	84.6%	<.001
	RidgeIdentity	1 if the respondent agreed or strongly agreed with the statement 'living on the Ridge is part of my identity'	63.3%	41.5%	<.001
	ConfidentWildfires	1 if the respondent agreed or strongly agreed that 'I am confident about my ability to handle wildfires'	53.6%	36.1%	<.001
	WishSafer	1 if the respondent agreed or strongly agreed with the statement 'I wish I could live somewhere safer'	32.9%	32.0%	*not sig.*
	WildfireAffectsDecisions	1 if the respondent agreed or strongly agreed with the statement 'wildfire affects my decision-making'	58.2%	68.9%	*not sig.*
	ThinkFireOften	1 if the respondent agreed or strongly agreed with the statement 'I think about wildfire often'	55.3%	62.7%	*not sig.*
Responsibility for the	BlameClimateVery	1 if the respondent indicated that 'climate change' was 'very	27.2%	28.6%	*not sig.*

Wildfire Disaster		responsible' for the wildfire disaster			
	BlameLoggingVery	1 if the respondent indicated that 'environmental / logging policies' were 'very responsible' for the wildfire disaster	39.6%	34.0%	<.05
	BlameLanduseVery	1 if the respondent indicated that 'land use / housing policies' were 'very responsible' for the wildfire disaster	21.8%	19.1%	*not sig.*
	BlameLocalgovVery	1 if the respondent indicated that 'local government decisions' were 'very responsible' for the wildfire disaster	35.3%	31.1%	*not sig.*
	BlamePgeVery	1 if the respondent indicated that 'Pacific Gas and Electric (PG&E)' was 'very responsible' for the wildfire disaster	77.9%	88.4%	*not sig.*
	BlameFirefightingVery	1 if the respondent indicated that 'wildfire fighting practices' were 'very responsible' for the wildfire disaster	24.8%	25.3%	*not sig.*
Respondent Identities and Characteristics	BeforeEmploy	1 if the respondent indicated that they were employed in 2018 immediately prior to the wildfire	59.3%	47.3%	<.001
	SameEmploy	1 is the respondent indicated that they worked for the same employer they did in 2018	14.6%	14.1%	*not sig.*
	AgeCurrent	Age of the respondent on their last birthday	59.08	65.09	<.001
	HouseholdSize	Total number of people in the households including children	2.27	2.25	*not sig.*
	BachelorsAbove	1 if the respondent indicated their highest	44.2%	46.5%	*not sig.*

	level of education as a bachelor's degre eor higher			
NonWhite	1 is the respondent indicated any racial or ethnic identity categories other than 'white' alone	17.3%	8.7%	*not sig.*
Female	1 if the respondent indicated a gender identity of 'female'	69.8%	65.6%	*not sig.*

Figure 4.11 summarizes the distribution of respondent ages across the "remained" group and the "relocated" group for those respondents who reported that their home was completely destroyed in 2018. The average age of those who remained in Paradise was 58.5, while the average age of those who relocated was 64.8. This distribution suggests that older residents whose homes were destroyed were, on average, more likely to relocate than their younger neighbors, an assumption that is further tested in the first logistic regression model. As a community that was much older, on average, than the rest of California before the fire, a change in age composition would portend a significant change in the community's post-fire identity.

Figure 4.11. Distribution of respondent age by those remaining versus those relocated from Paradise for respondents who lost their home in 2018.

In order to determine each potential explanatory variable's unique contribution on a respondent's likelihood to have remained or rebuilt in Paradise versus relocated outside the fire footprint as of 2023, a logistic binary regression model was created and refined using the Purposive Selection Method outlined in the previous section. The resultant model yielded moderately predictive results, with a Nagelkerke Pseudo-R-squared value of .3237 suggesting that roughly a third of the variation in the dependent variable can be predicted using the 12 predictors listed in the regression results in Table 4.3.

Table 4.3 Results of Binary Logistic Regression Model Predicting Likelihood of Respondents Remaining on the Ridge

Variable	Coefficient [Standard Error]	Exponentiated Coefficient	P-Value

HouseDestroyed	-1.867 [0.245] ***	0.155	.0000000000000232
BeforeMobile	-0.721 [0.306] **	0.486	.0183
BeforeHousingBurden	-0.471 [0.240] *	0.625	.0501
BeforeReasonSchoolQual	1.143 [0.489] **	3.137	.0194
YardImportant	0.634 [0.338] *	1.884	.0610
RidgeIdentity	1.084 [0.206] ***	2.955	.000000154
ConfidentWildfires	0.483 [0.197] **	1.620	.0142
WildfireAffectsDecisions	-0.485 [0.209] **	0.616	.0203
BlameLocalgovVery	0.495 [0.209] **	1.641	.0180
BlamePgeVery	-0.545 [0.281] *	0.580	.0525
AgeCurrent	-0.027 [0.007] ***	0.973	.00023
NonWhite	0.663 [0.332] **	1.941	0.046
Constant	2.751 [0.731] ***	15.652	.00017

Nagelkerke Psuedo-R2: .3237; n = 592

**p<0.1; **p<0.05; ***p<0.01*

The exponentiated coefficients on the model's predictors serve as odds ratios that elucidate the magnitude of each contributing variable's effect on the propensity to have remained in Paradise.

Unsurprisingly, losing one's home entirely in the fire was a very strong predictor of a respondent's propensity to remain in Paradise, with the odds of respondents in this group remaining being 84.5% less than the odds of those who did not suffer total home loss. Two additional predictors related to housing were important in the final model specification: whether or not the respondent lived in a mobile home prior to the fire, and whether or not the respondent was considered housing burdened (spent over 30 percent of their household's income on housing) prior the fire. Those living in mobile homes had less than half the odds of their former neighbors in other types of housing to have remained in Paradise, while those who were

considered housing burdened had 37.5% lower odds as their non housing-burned peers to have remained on the Ridge.

In terms of reasons why respondents were initially attracted to Paradise, only one predictor stood out as important in the model – respondents who reported that the quality of local schools was an important reason behind their initial move. Respondents in this group were over three times as likely as their peers to have remained in Paradise. It should be noted that this response might also simply be capturing the effect of having children in the home; this question was not directly asked to survey respondents; rather, we only asked about their total household size.

Two predictors related to respondents' preferences and risk perceptions were also significant in this model: respondents' confidence in their ability to handle future wildfires, and the extent to which they report that wildfire affects their decision-making. These variables point in different directions with respect to remaining in Paradise: those who deem themselves confident about their ability to handle wildfires had greater odds than their peers to have remained, while those who reported that wildfire affects their decision-making had lower odds compared to their peers to have remained. Taken together, these coefficients suggest that households who take wildfire more seriously as a future threat were less likely to remain in Paradise.

Respondents' beliefs about the causes of the wildfire disaster were predictive over their current location in two categories: their blame for "local government decisions," and their blame for Pacific Gas and Electric. Respondents who held local government decisions as "very responsible" for the disaster had higher odds compared to their peers to have remained, while those who deemed PG&E "very responsible" had much lower odds to have remained. Interpretation of these variables is not immediately clear: while an initial assumption might be that disagreement with local government decisions might be a factor driving residents away, an

alternate assumption could be that this dissatisfaction might be a motivating factor to remain and contribute to policy change in the rebuilding process. The PG&E variable was a surprising finding; as the vast majority of survey respondents deemed the entity "very responsible" and, as noted previously, the company was deemed legally responsible months before the survey was administered. It may be that those who were displaced continue to have more bitter attitudes toward the company.

Finally, two demographic variables were predictive in the final model: respondents' age and race. With every one-year increase in respondent age, the respondent has an additional 2.7 percent lower odds to have remained in Paradise. Respondents who indicated any racial identity other than white alone had much greater odds of remaining in Paradise compared to their peers with an identity of white alone; in a seeming divergence from much literature about the role of race as a component of social vulnerability in disaster.

Determinants of Displaced Residents' Desire to Return to the Ridge

This section explores the determinants of relocated residents' responses to a question about their willingness to move back to Paradise under a hypothetical "ideal" scenario. Table 4.2 summarizes 48 predictors that were tested against respondents' willingness to at least consider moving back to the Ridge (those who responded "yes" or "maybe" about moving back) versus those who said no they would not move back under any circumstances. Each of the variables listed in Table 4.2 were tested against the *MoveBackYesMaybe* variable, but only six warranted inclusion in the final model given their significance and collinearity with other predictors. In exploring this relationship, several additional banks of questions were tested that were not tested

in support of the first regression predicting remainers versus relocatees – especially important here are variables representing reported changes in various quality of life metrics between respondents' pre-fire and post-fire neighborhoods. As in Table 4.2, binary significance is indicated via a Chi-square test (or a T-test for three numeric variables including years the respondent lived in Paradise before the fire, age, and household size) in the last column of the table, but this was not considered in fitting the regression model.

Table 4.4. Potential factors predicting displaced respondents' stated preference to move back to the Ridge as indicated by responding "yes" or "maybe" to a question asking "under ideal circumstances, would you return to [your 2018 community]?

Variable Type	Variable	Description	"Yes" or "Maybe" (n = 142)	"No" (n = 99)	Chi-Sq or T-Test P-value
Dependent	MoveBackYM	1 if respondent lived in the fire footprint in both 2018 and 2022	58.9%	41.1%	-
Housing and Tenure Characteristics	BeforeOwn	1 if respondent owned their residence in 2018	81.7%	92.9%	<.05
	AfterOwn	1 if respondent owned their residence in 2022	90.9%	77.5%	<.05
	BeforeHousingBurden	1 if respondent indicated they spent over 30% of their income on rent in 2018	30.3%	24.2%	*not sig.*
	AfterHousingBurden	1 if respondent indicated they spent over 30% of their income on rent in 2022	18.2%	29.6%	<.05
	BeforeMobile	1 if respondent indicated their residence in 2018 was a mobile home	14.1%	15.5%	*not sig.*
	AfterMobile	1 if respondent indicated their residence in 2022 was a mobile home	6.1%	5.6%	*not sig.*
	BeforeMultifamily	1 if respondent indicated their residence in 2018	3.5%	5.1%	*not sig.*

		was in a multifamily building			
	AfterMultifamily	1 if respondent indicated their residence in 2022 was in a multifamily building	3.0%	8.5%	*not sig.*
	YearsBeforeFire	# of years respondents lived on the Ridge prior to the wildfire	19.0	21.1	*not sig.*
	AllAdultLife	1 if respondent indicated they had lived on the Ridge for 'most of all of [their] adult life'	28.3%	38.7%	*not sig.*
Reasons Respondent Lived on the Ridge	BeforeReasonAfford	1 if the respondent indicated that 'affordability' was a reason they initially moved to the Ridge	35.2%	28.3%	*not sig.*
	BeforeReasonClimateEnv	1 if the respondent indicated that 'attractive climate / environment' was a reason they initially moved to the Ridge	39.4%	33.3%	*not sig.*
	BeforeReasonEmployment	1 if the respondent indicated that 'employment' was a reason they initially moved to the Ridge	10.6%	8.1%	*not sig.*
	BeforeReasonFamFriendly	1 if the respondent indicated that 'family-friendliness' was a reason they initially moved to the Ridge	17.6%	13.1%	*not sig.*
	BeforeReasonProximity	1 if the respondent indicated that 'proximity to family/friends' was a reason they initially moved to the Ridge	26.8%	16.2%	<.05
	BeforeReasonNature	1 if the respondent indicated that 'proximity to nature / outdoor recreation' was a reason they initially moved to the Ridge	35.9%	21.2%	<.05

	BeforeReasonPrivacy	1 if the respondent indicated that 'privacy' was a reason they initially moved to the Ridge	21.8%	10.1%	<.05
	BeforeReasonSchoolQual	1 if the respondent indicated that 'school quality' was a reason they initially moved to the Ridge	4.2%	3.0%	*not sig.*
	BeforeReasonSocialRel	1 if the respondent indicated that 'social or religious community' was a reason they initially moved to the Ridge	7.7%	6.1%	*not sig.*
Changes in Community Satistfaction Pre- and Post-Fire	DropCost	1 if the respodent characterised the 'cost of living' in their 2022 neighborhood as worse than their 2018 neighborhood on the Ridge	49.5%	69.0%	<.05
	DropComm	1 if the respodent characterised the 'community' in their 2022 neighborhood as worse than their 2018 neighborhood on the Ridge	39.4%	59.9%	<.05
	DropEnv	1 if the respodent characterised the 'environment' in their 2022 neighborhood as worse than their 2018 neighborhood on the Ridge	34.3%	60.6%	<.001
	DropConv	1 if the respodent characterised the 'location/convenience' in their 2022 neighborhood as worse than their 2018 neighborhood on the Ridge	30.3%	49.3%	<.05
	DropSafe	1 if the respodent characterised the 'public safety' in their 2022 neighborhood as worse than their 2018	25.3%	54.9%	<.001

		neighborhood on the Ridge			
Respondent Preferences and Perceptions	YardImportant	1 if the respondent agreed or strongly agreed with the statement 'having a house with a yard is important to me	85.9%	82.8%	*not sig.*
	RidgeIdentity	1 if the respondent agreed or strongly agreed with the statement 'living on the Ridge is part of my identity'	53.5%	24.2%	<.001
	SenseBelonging	1 if the respondent agreed or strongly agreed with the statement 'I feel a sense of belonging in my community'	50.5%	42.3%	*not sig.*
	LiveRestLife	1 if the respondent agreed or strongly agreed with the statement 'I want to live where I am now for the rest of my life'	60.6%	24.6%	<.001
	ConfidentWildfires	1 if the respondent agreed or strongly agreed that 'I am confident about my ability to handle wildfires'	33.1%	40.4%	*not sig.*
	WishSafer	1 if the respondent agreed or strongly agreed with the statement 'I wish I could live somewhere safer'	40.1%	20.2%	<.01
	WildfireAffectsDecisions	1 if the respondent agreed or strongly agreed with the statement 'wildfire affects my decision-making'	69.7%	67.7%	*not sig.*
	ThinkFireOften	1 if the respondent agreed or strongly agreed with the statement 'I think about wildfire often'	65.5%	58.6%	*not sig.*
Responsibility for the	BlameClimateVery	1 if the respondent indicated that 'climate change' was 'very	27.5%	30.3%	*not sig.*

Wildfire Disaster		responsible' for the wildfire disaster			
	BlameLoggingVery	1 if the respondent indicated that 'environmental / logging policies' were 'very responsible' for the wildfire disaster	37.3%	29.3%	*not sig.*
	BlameLanduseVery	1 if the respondent indicated that 'land use / housing policies' were 'very responsible' for the wildfire disaster	17.6%	21.2%	*not sig.*
	BlameLocalgovVery	1 if the respondent indicated that 'local government decisions' were 'very responsible' for the wildfire disaster	28.2%	35.4%	*not sig.*
	BlamePgeVery	1 if the respondent indicated that 'Pacific Gas and Electric (PG&E)' was 'very responsible' for the wildfire disaster	88.0%	88.9%	*not sig.*
	BlameFirefightingVery	1 if the respondent indicated that 'wildfire fighting practices' were 'very responsible' for the wildfire disaster	26.1%	24.2%	*not sig.*
Respondent Identities and Characteristics	BeforeEmploy	1 if the respondent indicated that they were employed in 2018 immediately prior to the wildfire	49.3%	44.4%	*not sig.*
	SameEmploy	1 is the respondent indicated that they worked for the same employer they did in 2018	14.8%	13.1%	*not sig.*
	AgeCurrent	Age of the respondent on their last birthday	63.6	67.3	<.05
	AgeRetirement	1 if the respondent was 65 or over	66.7%	52.8%	<.05
	HouseholdSize	Total number of people in the households including children	2.3	2.2	*not sig.*

BachelorsAbove	1 if the respondent indicated their highest level of education as a bachelor's degre eor higher	46.5%	46.5%	*not sig.*
NonWhite	1 is the respondent indicated any racial or ethnic identity categories other than 'white' alone	7.0%	11.1%	*not sig.*
Female	1 if the respondent indicated a gender identity of 'female'	67.6%	62.6%	*not sig.*
StillClose50	1 if the centroid of the respondent's self-reported ZIP code is within 50 miles of the Camp Fire perimeter	32.3%	48.6%	<.01

This analysis includes an additional dimension not included in the first analysis: the distance from Paradise to each of the respondents' current residential locations. Recall earlier in Figures 4.5 and 4.6 that there were small but significant differences in average relocation distance between those respondents responding "no," "maybe," and "yes" to returning to Paradise under ideal circumstances. Initially, a linear term representing miles from Paradise was tested, but was found to have little significance with willingness to return. To better capture the break point at which distance starts to matter, Figure 4.11 below shows a crosstabulation between willingness to return and the same distance bins used in Figure 4.2. Here we see a few important break points, including a marked decrease in "no" responses among those less than 50 miles from Paradise. The relationship between these distance categories and the willingness to return question is significant using a Chi-squared test at a 99% confidence level, and a binary variable representing respondents within 50 miles of the burn perimeter was ultimately significant in the final model presented in Table 4.4.

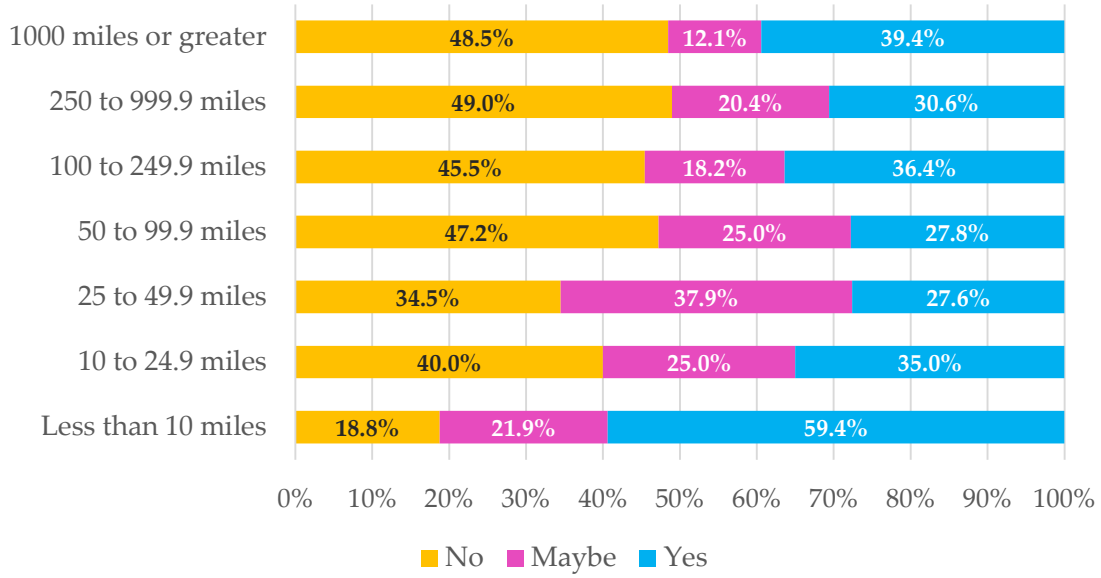

Figure 4.11. Distribution of respondent age by those remaining versus those relocated from Paradise for respondents who lost their home in 2018.

To assess significant predictors of relocated respondents' willingness to return to Paradise, another binary logistic regression was constructed that predicted respondents' willingness to at least consider returning. This model yielded somewhat predictive results, with a Nagelkerke Pseudo-R-squared value of .3357 suggesting that just over a third of the variation in the *MoveBackYesMaybe* variable can be predicted using the 8 predictors listed in the regression results in Table 4.5.

Table 4.5. Results from binary logistic regression predicting displaced respondents' stated preference to move back to the Ridge as indicated by responding "yes" or "maybe" to a question asking "under ideal circumstances, would you return to [your 2018 community]?

Variable	Coefficient [Standard Error]	Exponentiated Coefficient	P-Value
BeforeOwnYes	-1.090 [0.624]*	0.336	0.081
BeforeReasonProximity	1.095 [0.453] **	2.988	0.016

DropSafe	0.745 [0.375] **	2.106	0.047
RidgeIdentity	1.076 [0.354] ***	2.933	0.0024
LiveRestLife	-1.305 [0.345] ***	0.271	0.00015
BlameLogging	0.678 [0.364] *	1.970	0.062
AgeCurrent	0.002 [0.014]	1.002	0.868
NonWhite	-0.181 [0.626]	0.834	0.772
StillClose50	0.735 [0.347] **	2.086	0.034
Constant	-0.478 [0.362]	15.652	0.187

Nagelkerke Psuedo-R2: .3514; n = 205

**p<0.1; **p<0.05; ***p<0.01*

Significant predictors spanned multiple variable categories including preferences, blame for the fire, and geographic location. Respondents who indicated that "proximity to family and friends" was a factor that first attracted them to Paradise were nearly three times more likely than their peers to entertain the idea of returning to Paradise. No other responses to the set of questions asking respondents what attracted them to Paradise were significant in the final model. NonWhite and AgeCurrent were included despite high p-values since literature suggests they might be important and to provide a better comparison with the first regression model.

Respondents who indicated a drop in safety (on a 5-point scale) between their former Ridge neighborhood in 2018 and their current neighborhood in 2023 had much higher odds than their peers who did not report a change in safety to indicate a willingness to return to Paradise. This was the only quality of life indicator that warranted inclusion in the final model.

Two variables related to respondent identity were strongly predictive of willingness to return to Paradise. The first, respondents who indicated that living on the Ridge was "part of their identity," had nearly 200% higher odds compared to their peers to desire a return to Paradise.

Conversely, respondents who agreed that "I want to live where I am for the rest of my life" perhaps unsurprisingly had lower odds than their peers of entertaining the notion of returning to the Ridge.

A single blame category was significant in this model: respondents who deemed "logging / environmental practices" very responsible for the fire disaster had much higher odds of indicating a willingness to return to Paradise compared to their peers who did not indicate this factor as "very responsible" for the disaster.

Lastly, geographic location was a significant predictor of willingness to return, with respondents who lived within 50 miles of the burn perimeter having higher odds than their peers living farther than 50 miles of considering returning to the Ridge. No other demographic or household variables including household size, respondent age, gender, or race were significant predictors in this model.

Discussion

Implications

The regression analysis of the survey data yielded interesting results, that at times differed from the conclusions of other displacement literature. Because this is, to the author's knowledge, the first project aiming to predict relocation and willingness to return in the wake of a wildfire, such differences might be expected. This work also found significance in several as-of-yet unexplored social dimensions of the return decision – including the element of blame or culpability for the disaster event, and the change in neighborhood satisfaction from the pre-disaster time period to the post-disaster time period.

Regression 1 found a myriad of factors that helped predict whether or not households stayed in Paradise more than four years after the wildfire disaster. Consistent with previous literature (Paul et al., 2024), numerous indicators related to housing were strongly predictive – including total destruction of the respondent's home (higher odds of relocating), living in a mobile home (higher odds of relocating), and spending more than 30 percent of household income on housing (higher odds of relocating). It is worth noting that the mobile home and cost burden variables are likely significant in part because they indirectly capture income information, which was not asked about in this survey but has been widely observed as a predictor.

Numerous measures of place attachment and residential satisfaction were also significant predictors of households that remained versus relocated, in line with previous work in the tornado (Greer et al., 2020) and earthquake (Costa et al., 2022) realms. After household destruction, the next two most significant predictors in this model captured aspects of place attachment – through agreeing that living on the Ridge is part of the respondent's identity (higher

odds of remaining) and stating that local schools were a factor that first attracted the respondent to Paradise (higher odds of remaining).

In line with expectations, respondents who stated that they were confident about their ability to handle wildfire (suggesting a low risk perception) had higher odds of remaining, while respondents who stated that "wildfire affects their decision-making" (suggesting a higher risk perception) had greater odds of relocating. Perhaps those confident in their ability to handle wildfire were also under the spell of the "gambler's fallacy" described by Mockrin (2015), with a false sense that the same disaster can't happen twice. Again it is worth noting here that as I write this discussion in July 2024, large portions of Paradise are again under evacuation warnings from a raging wildfire, suggesting that the Camp Fire has not made Paradise invulnerable to future fires.

Lastly and perhaps most interestingly, age and race influenced households' propensity to remain or relocate in an opposite direction to most literature on this topic. Whereas a plethora of studies of hurricane and tornado disasters find that older residents are more likely to remain and rebuild (Cong et al., 2018; Groen & Polivka, 2010; Hu et al., 2019), the findings here indicate that older residents had much greater odds of relocating away from Paradise. Perhaps Paradise's already older-than-average population creates a different set of determinants, like the presence of adult children whose homes become relocation destinations. Perhaps there is something unique to widespread wildfire destruction that makes a relocation seem more attractive to older residents as compared to hurricane or tornado events. The overall older skew of the survey data may also be partly responsible for this pattern. Regardless of why, the question of how age continues to change in Paradise is an interesting one to follow, as Paradise may have shed its reputation as a retirement community in the wake of the fire and in the rebuilding process. Similarly, most

hazards literature would suggest that nonwhite populations would be the most likely to remain displaced and relocated, as was certainly the case in Hurricane Katrina (Fussell et al., 2010; Landry et al., 2007). Here, however, respondents indicating a racial identity other than white alone had much greater odds of remaining in Paradise and on the Ridge. Paradise for many decades was predominantly white, although this had begun to change in the 2010 census; perhaps the fire event merely sped the rate of demographic change that was already underway. Perhaps those most eager to relocate to lower cost locations – especially those relocating outside California to places to which some Paradise residents might have felt more politically aligned – were also more likely to be white. Regardless of the explanatory mechanism, the reversal of the typical patterns in age and race are notable here and warrant further exploration.

While New Orleans emerged as an older and less diverse community after Hurricane Katrina, the findings here suggest that Paradise may build a new identity that is more diverse and more geared toward younger households as compared to its pre-fire retirement community roots. However, comparisons to New Orleans can only go so far. As a large metropolitan area, damage and reconstruction in New Orleans was markedly stratified by neighborhood and strongly correlated with pre-fire racial and income segregation (Fussell et al., 2010), while the Ridge is not only a smaller geographic area, but exhibited less pre-fire social stratification and more evenly distributed damage from the wildfire (Wallingford, 2018). Therefore, we might not expect the same spatially differentiated patterns of recovery experienced in New Orleans or countless other disaster contexts like earthquakes and river flooding (Rovai, 1994; Tobin & Montz, 1997). The changing demographics of Paradise might also mean a different set of vulnerability characteristics if and when the next wildfire threatens the area.

Regression 2, which explored respondent's stated willingness to return (or not) to Paradise and the Ridge, also contained interesting results that at times conflict with previous literature, and also explored new dimensions of willingness to return to an area after a disaster. Most significant to this model were two place attachment metrics – respondents who agreed "I want to live where I am for the rest of my life" were unsurprisingly at much greater odds of stating that they had no interest in moving to Paradise, while those who agreed that "living on the Ridge is part of my identity" had much greater odds of desiring a return. The Ridge identity question was also strongly predictive of observed data on households that remained versus relocated, suggesting that place attachment is one of the strongest influencers on who ultimately returns to Paradise in the short term and in the long term. Respondents who stated that "proximity to friends and family" was one of the factors that initially attracted them to Paradise also had greater odds of wanting to return, suggesting that place attachment through social capital is similarly important to individual identities tied to place.

It is somewhat surprising that respondents who owned their homes before the fire actually reported lower odds of wanting to return, rather than greater odds as most relocation literature would suggest (Paul et al., 2024). Perhaps homeowners had greater access to capital and/or insurance that allowed for a wider range of options including distant relocation after the fire. Unfortunately, the survey did not ask specifically about insurance or any other payouts, including from the PG&E lawsuit that had just been settled at the time of survey administration (Associated Press, 2022). The influx of such payments, disproportionately to homeowners, might have aided in their early relocation, giving them greater choice and thus satisfaction in their chosen relocation destination. Neighborhood satisfaction as measured by perceptions of safety in the community was also a significant predictor, with those who reported feeling less safe in their

current neighborhood than they did in Paradise having higher odds of wanting to return. “Safety” was not specifically defined in the survey text, so it is impossible to know with certainty whether or not respondents were thinking about hazard risk or safety from personal or property crime; however, no other measures of hazard risk perception were significant in this model, suggesting that respondents might have been thinking about neighborhood crime when answering this question.

From the perspective of Paradise’s recovery, insights gained from the regression regarding intent to return may give insight into the kind of community Paradise will become long into the post-fire period. In the broadest sense, the fact that a majority of survey respondents indicated a desire or openness to return to Paradise suggests that housing supply and reconstruction has not yet come close to reaching the demand for housing in Paradise. Alternatively, a lack of economic or other opportunities may be hampering the potential return of these households. Taken together, the finding that respondents who reported a drop in safety and respondents who remained within 50 miles of Paradise are both more likely to desire to return might suggest that there are many households displaced to nearby larger communities like Chico and Oroville who yearn to return to what they view as a more attractive lifestyle on the Ridge.

Finally, one of the secondary objectives of this effort was to extend the current literature about social factors in disaster relocation and return by exploring the role of culpability and blame as measured by the factors or entities respondents felt were “responsible” for the wildfire disaster. While my initial suspicion guided by personal contacts was that respondents who deemed climate change responsible would be less likely to return (recognizing that wildfire risk would likely only grow with time), blame in climate change was not a significant predictor of willingness to return to Paradise. However, belief that “Logging / Environmental Policies” were

at least partly responsible for the fire lead to greater odds of respondents wanting to return; potentially the inverse of my initial climate change awareness scenario. Perhaps those who blame logging and environmental practices, opposite of those who blame climate change, believe they have more agency over future decision-making, as logging and forest management policies can be affected on a local and state level, unlike greenhouse gas emissions which require global coordination. On the other hand, belief in these practices as responsible for fire may merely be a proxy for political affiliation, which was not directly asked about in this survey. It should be noted that it was during a visit to Paradise that then-president Donald Trump declared that the fire had taken place because we had failed to "rake the forest" (Selk, 2018), surely an attempt at blaming environmental policies. Nevertheless, this is a novel finding that warrants additional exploration in this and other hazard scenarios. If disaster-affected residents believe that the ultimate cause of the disaster can be entirely addressed on a local level, they may underestimate the true climate-driven risks of returning. In the long run, this may lead to a sorting effect wherein those who are more climate-aware are less likely to return to disaster-affected areas, leading to increasingly uneven exposure to climate-driven hazards along educational and climate-awareness lines, consistent with many framings of "climate gentrification" (Keenan et al., 2018). Future work should more directly interrogate these questions among those making rebuilding and relocation decisions in the wake of wildfires and other climate-driven hazards.

Limitations

While I believe this project has uncovered many interesting threads related to Camp Fire survivors and their decisions about remaining or relocating, there are important caveats in generalizing this work that must be addressed. Firstly, it's worth noting that the results from

Regression 1 might be more generalizable and useful than those in Regression 2 since the first regression is predicting *observed outcomes*, while the second regression is merely predicting *stated preferences*. Further, the dependent variable in Regression 2 is constructed from a hypothetical question about returning to Paradise "under ideal circumstances," which may never materialize for many households. While the findings of this regression are still interesting, caution should be exercised in generalizing these results to other disaster recovery scenarios.

Next, this project draws from a multi-pronged survey effort that aimed to collect a myriad of data from fire survivors, and, in the process, some questions were not asked in an ideal way. Importantly, any interpretation of the meaning behind the "Logging / Environmental Policies" question must be taken lightly, as the double-barreled nature of this answer choice could point to two conflicting meanings. My intended meaning with this answer choice was to point toward the "lack of logging" rhetoric that is common among those with conservative-leaning views in the area, but an alternate interpretation could be more broadly "lack of forest management" which might include regular prescribed burns and dovetail nicely with climate-aware management rather than serve as an alternate explanation. Another survey question shortcoming was the lack of a question about insurance and/or PG&E payouts. Future research related to this topic should absolutely focus greater attention on the role these financial mechanisms play in a wildfire context, especially as California grapples with rapidly rising fire insurance premiums and the creation of new state-subsidized insurance plans (Sumagaysay, 2024).

Lastly, the survey process itself was subject to several flaws and biases that are likely to affect regression results and interpretation. The multi-pronged survey effort visualized in Figure 1 helped increase the overall number of completed surveys, but makes response rates unreliable as sampled households were augmented by social media and in-person survey distribution. Further,

the consumer information obtained to set the survey universe for the mail-based survey recruitment was likely biased toward older, more stable homeowners with better established financial paper trails, which likely means that lower-income households, individuals moving between households or living with family, and those outside the formal financial market (of which there were many in Paradise before the fire) were less likely to be sampled. Chase and Hansen (2020) elucidate the property-bias in disaster recovery research in regards to this very fire event, and this study reinforces their point that marginalized populations including renters are often overlooked and undersampled. Other survey recruitment methods were intended to overcome these hurdles somewhat, but they also introduced their own biases, as the majority of social media recruitment originated within my own social network through family members and high school friend groups which may not be demographically, politically, or economically reflective of the general population in Paradise and the surrounding Ridge communities. My own positionality as a researcher is likely to have also introduced bias – not only in survey question construction, but also along the lines of social desirability bias, as many survey respondents are friends or acquaintances who may not have felt the freedom to be entirely candid despite the IRB assurance of respondent confidentiality. Nevertheless, this positionality has also served as a double-edged sword, as I believe my closeness to the phenomena also aided the overall response rate and willingness to participate in this work.

Conclusions

This project analyzed a survey of more than 600 survivors of the 2018 Camp Fire in Paradise, California. The survey, conducted more than four years after the disaster event, aimed to better understand the factors associated with remaining and rebuilding in Paradise, versus relocating elsewhere in the long term. We found that housing tenure, type, and affordability; place attachment to Paradise and/or the Ridge; perceptions about future wildfire risk; and age and race all play a significant role in helping explain which households remain in Paradise and which remain long-term relocated; with relationships that sometimes run counter to what has been observed in previous disaster recovery scenarios. Further, among those households that are still long-term relocated, more than a third have no desire to ever return to Paradise. Place attachment, neighborhood satisfaction, and even respondents' perception of culpability for the wildfire disaster are all predictive of a relocated household's stated desire to return to Paradise (or not).

As Paradise continues to rebuild and regain population after it was decimated in 2018, these findings may help Town planners and policymakers anticipate which populations are most likely to return, and what they value about the community they left behind more than five years ago. Disaster researchers may also be able to learn valuable lessons from the experience of Camp Fire survivors, especially as long-term recovery is just beginning in the wake of other major wildfire disasters spanning from Lahaina to just several ridges over from Paradise in the Park Fire that continues to burn unabated in July 2024.

The Camp Fire remains one of the deadliest and most destructive wildfires in American history. The lessons learned in this and other studies related to this disaster are likely to aid those

responding to and planning for communities with a similar susceptibility to wildfires. It is my sincere hope as a Paradisian that this work might in some small way help increase the resilience of this community and others facing similar climate-driven hazards.

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CHAPTER 5: Conclusions and Future Research

This dissertation explored climate migration and climate gentrification by tracking changes in real-estate values and populations in disaster-affected communities throughout the American West. This work bridged secondary data analysis with survey data collected from wildfire survivors to better understand how disaster events affect real-estate markets, cause internal migration, and shape preferences about where to live. Chapter 2 examined the impact of fluvial flooding on real-estate markets across three counties, finding that how a flood disaster is perceived is predictive of how prices respond in floodplain areas. Chapter 3 detailed the displacement that resulted from the 2018 Camp Fire, finding a widespread diaspora that put many fire survivors back into areas with wildfire threat. Finally, Chapter 4 explored long-term displacement and residential preferences among the survivors of this disaster; finding that many wildfire survivors have no desire to return, and that beliefs about fire risk and even the causes of the fire were predictive of their willingness to return. This section briefly summarizes the findings of each project and highlights contributions to their broader respective fields, before addressing future research needs and the policy implications of this work.

Chapter 2 used Zillow data to assess how flood events affected real-estate markets in three U.S. counties corresponding to mid-size cities: Benton County, Oregon (Corvallis), Boulder County, Colorado (Boulder), and Cass County, North Dakota (Fargo). In each market, a hedonic regression model was first built that predicted real estate prices based on property and spatial attributes. Next, binary terms for floodplain presence and time of sale relative to the flood event, as well as their intersection, were added into the model. This method, termed difference-in-differences by economists and used by many flood researchers (Atreya et al., 2013; Bin &

Landry, 2013), mimics a traditional experimental research design. It allows researchers to isolate the unique effects of a "treatment" (the flood) on a "treatment group" (the floodplain). Each county's flood event was observed to have had a unique effect on real-estate prices in their floodplain areas. In Boulder County, statistically significant price discounting was observed for between 2 and 3 years after the flood event. Benton County did not see a significant price discount after its flood event, but real-estate prices in the floodplain remained nearly 10% lower than comparable properties throughout the study period, suggesting that flood risk might have already been "priced in" to the market here. Lastly, properties in Cass County's floodplain areas declined slightly but not significantly within the regression model. Residents may have been basing real estate value on the expected future benefits of a large diversion channel which promised to eliminate flood risks in Fargo (Gundersen, 2018).

This work represented a novel extension of real estate aggregator data to rapidly test hypotheses in different locations for which data might otherwise be difficult to acquire from county assessor's offices. It also provides a direct empirical test of Tobin and Montz' landmark flood effects model (Tobin & Montz, 1997) which posits that flood disasters have differential impacts on real-estate markets based on pre-flood and post-flood perceptions of flood risk. It also extends this work into the climate-informed model proffered by Pryce (2011) which suggests that real-estate prices should continue to fall as climate change worsens flood outcomes. Benton County can be seen as a location in which climate-driven flooding on the Willamette River may already be priced into the market, whereas Boulder County viewed its 2013 flood event as a "freak event" and thus it did not have a long-lasting impact on prices. Understanding how real-estate prices change in relation to disaster events and subsequent changes in risk perception will be key to measuring climate-driven gentrification throughout the United States into the future.

Chapters 3 and 4 examined a single disaster event: the 2018 Camp Fire, the deadliest and most destructive wildfire event in California history. Chapter 3 used consumer databases to visualize the diaspora of families from the burned area and examined socioeconomic determinants of relocation distance and destinations, while Chapter 4 provided much-needed depth to this inquiry by surveying residents about their experiences, perceptions, and long-term relocation preferences. In Chapter 3, a consumer credit database was purchased for the Camp Fire area that provided location information for over 8,112 households who lived within the burned area in 2018. Of that group of households living in the burned area in 2018, 3,165 (39.0% of the total) lived *outside* the fire footprint as of 2022. These relocated households had scattered across the United States by 2022, with dozens of households in nearby West Coast states and outlying clusters in locations like Texas and Tennessee. Statistical modelling showed that certain householder attributes were correlated to a household's likelihood of living outside the fire perimeter in 2022, including older residents, those who owned their homes, and those who had lived in Paradise for fewer years leading up to the 2018 wildfire.

This chapter also explored the wildfire threats in relocation destinations, finding that more than half of all households identified for this project remained in areas with wildfire threat. Even more concerningly, a household's pre-fire home value was shown to be positively associated with a household's likelihood of ending up in a "very high" fire severity zone. Taken together, these results show that Paradise may differ from the dominant wildfire narrative in California, which suggests that Californians in wildfire areas are there by choice (Davis, 1995; Schumann et al., 2024). These results also diverge from disaster recovery and relocation research done in other contexts including Hurricane Katrina, where older residents were found to be more likely to *return* rather than relocate (Groen & Polivka, 2010; Landry et al., 2007; Paul et al., 2024;

Vigdor, 2007). They also raised interesting questions about determinants and motivations for relocating that are not easily observable through secondary data analysis.

Chapter 4 provided additional insight into the Camp Fire diaspora by collecting survey information from 612 households who lived through the fire, 371 of whom remained in Paradise and 241 of whom were relocated nearly five years after the wildfire. This survey was collected throughout the spring and summer of 2023 through three primary mechanisms: sending physical mail invitations to the addresses found as part of the Chapter 3 analysis, direct survey recruitment through tabling at community events, and social media and snowball sampling starting through my own friends, family, coworkers, and social media contacts in the Paradise region. Survey participants were asked about their quality of life before and after the fire, their perceptions about wildfire risk and who or what was to blame for the wildfire disaster, and, crucially, those displaced by the wildfire were asked if they would return to Paradise "under ideal circumstances." Among displaced households, 36.1% said they would return, 22.8% said they might return, and 41.1% said they would not return under these hypothetical "ideal circumstances." When answers to this question were predicted based on other respondent attributes and attitudes, we found that those who wanted to move back to Paradise or the Ridge were more likely to have originally been in Paradise due to "proximity to friends and family," were more likely to have reported a drop in safety since being displaced from Paradise, and were more likely to have responded affirmatively to questions assessing place attachment. Those who desired to move back where also more likely to be "locally displaced" within 50 miles of the Camp Fire burn area, and, interestingly, were more likely to have indicated that "logging / environmental practices" were a contributing factor to the fire.

Regression modelling was also used to assess how respondent attributes might have differed between those who had remained or returned to Paradise in 2023 versus those who were still displaced. This analysis of "observed preferences" dovetails with the regression analysis performed on household attributes in Chapter 3, except that this survey data contained potential predictors unavailable in Chapter 3 including employment, race, perceptions, and preferences. This analysis revealed that many respondent attributes were correlated with a household's likelihood of staying versus remaining. The strongest predictors included having had one's home completely destroyed in the fire (negatively associated with remaining), stating that living on the Ridge is part of one's identity (positively associated with remaining), and age (negatively associated with remaining, in parallel to Chapter 3's results). The analysis also suggested with 95% confidence that nonwhite respondents were more likely to remain, as were respondents who said they were very confident about their ability to handle wildfires, who indicated "local government decisions" as a contributing factor to the fire disaster, and who indicated that an initial factor that drew them to Paradise was the quality of local schools. Respondents who indicated that they lived in a mobile home in 2018 and who agreed that "wildfires affect my decision-making" were less likely to remain in Paradise.

To my knowledge, this work is the first to explore the social determinants of wildfire displacement via survey data, although other researchers have examined wildfire displacement using aggregate data (DeWaard et al., 2024) and using secondary data for this same disaster area, earlier on in the recovery process (Chase & Hansen, 2021). This is far from the first work to explore long-term disaster displacement using survey data (Paul et al., 2024), and questions and analysis for Chapter 4 were heavily inspired by work done in the wake of Hurricane Katrina (Groen & Polivka, 2010; Hu et al., 2019; Landry et al., 2007; Vigdor, 2007). By incorporating

measures of place attachment and social capital in the survey process and in modelling relocation outcomes, this work also answers Alex Greer's call (2020) to extend place attachment work into all hazard types, and complements ongoing qualitative work done by other wildfire researchers in northern California using methods like long form interviews and photovoice (Zavar & Schumann, 2019).

Broader Impacts

Beyond this work's value to the academic community, the findings presented in this dissertation can also aid in planning for disaster recovery and in crafting policies that seek to minimize vulnerability and better respond to the preferences of those who are displaced. First, a major goal of this research is to help planners and residents of Paradise and the surrounding Ridge communities better plan for their future. Survey results presented in Chapter 4 can help inform the number of residents that might still be interested in returning to the Ridge – generalizing from the survey results suggests that about 36% of those who were displaced still yearn to return if only the "ideal circumstance" would materialize. On the other hand, it also suggests that 40% of displaced residents have no interest in returning, which may help the Town of Paradise' planners imagine a what a long-term growth ceiling might look like – perhaps with 40% fewer residents than before the fire. The social factors associated with remaining can also be used by local planners and decisionmakers – these results suggest that Paradise may slowly grow into a new identity that is less rigidly defined as a culturally homogenous retirement community. On the other hand, these results should also impact regional decisions about recovery and land use. Planners in nearby cities should plan to accommodate many displaced households indefinitely, as

many survey participants indicate no desire to return and have committed instead to rebuilding their lives in nearby cities including Oroville or Chico (Vigliotti, 2024).

Zooming out of northern California, planners and academics can also use similar methods to inform long-term displacement and relocation outcomes in the wake of future disasters including wildfires. Unfortunately, the pattern of ever more destructive and deadly wildfires does not appear to be abating, with 2023's wildfires in Maui and 2024's Park Fire in the Camp Fire's shadow just two examples of conflagrations that have displaced thousands once again. Understanding how wildfires and floods continue to affect communities through displacement and real estate markets will only grow in importance with climate change. To the extent that the Camp Fire, and the flood events described in Chapter 2, are at least partially the result of climate change effects, this work can also be considered as part of a growing body of literature regarding climate gentrification.

Limitations

There are several important limitations and caveats to the findings presented in this dissertation. Starting with Chapter 2, the individual real-estate market effects experienced by the three counties profiled in this chapter may not be generalizable to the rest of the United States. Two of the three counties are highly educated "college town" communities whose populaces may be especially attuned to hazard risk and the dangers of climate change, and the other is in a wholly unique flood management situation, currently the site of one the largest federal flood diversion projects in United States history. Further, the methods described in Chapter 2 are only of limited use to future research since the particular data sharing program that enabled the research

(Zillow's ZTRAX research collaboration program) was terminated in 2023. Researchers can still use competing data products or county assessor's data for such work, but it may require more time and cost.

In terms of Chapters 3 and 4 regarding the Camp Fire, it is important to note that the household relocation information and survey data presented here are an incomplete portrait of the Paradise and Ridge communities. Results should be generalized carefully, as it is certain that the household sample in Chapter 3 is biased toward wealthier, homeowning residents (a common concern in disaster recovery research as described by Chase and Hansen), and it is similarly certain that the survey sample described in Chapter 4 is biased toward older, more educated past and former residents of Paradise and the Ridge. This survey bias is partially a function of the bias in the householder sample described in Chapter 3, but also due to supplemental in-person and social media survey recruitment since many of these came from personal contacts. This work also failed to capture a significant number of residents who are "newcomers" to Paradise since the Camp Fire, who are certain to have their own perceptions about hazard awareness and what they would like to see the community grow into. Future research of Camp Fire survivors and this newcomer group to the Ridge is needed to construct a more complete picture of displacement and recovery.

Lastly, throughout this dissertation, I allude to the role of climate change and the specter of climate gentrification. While climate change is certainly changing the physical variables that affect the likelihood and severity of flood and wildfire events throughout the American West, these events are also the byproducts of elaborate human and social systems on a more local scale, including aspects like local land use decisions, forest and floodplain management policies, and, in the case of the Camp Fire, maintenance of electrical infrastructure. While climate change is

certainly an element in the disasters described in this dissertation, it is important to remember that it is not the only contributing factor. From the perspective of local planning, this should be seen as an opportunity: even amid an environment of changing physical conditions that we have little to no agency over on a local level, there are still things we can do to adapt to the new normal through local hazard mitigation efforts like prescribed burning and thinning, and building and planning regulations that prioritize flood and fire defense.

Future Research Needs

All three projects contributed as part of this work touch on the theme of climate gentrification, a topic that has gained traction and attention in the last decade within the realms of geography, planning, and disaster studies. Despite the growing focus on these themes, there remains a relative lack of empirical work that tests for the effects of such climate-driven gentrification by examining population or real-estate value changes across multiple hazard types. Much of the existing literature focusing on this topic is concerned with the effects of sea level rise (Keenan et al., 2018), which is an important but incomplete component of potential climate gentrification. While this dissertation contributed to broadening the understanding of climate gentrification by focusing on inland flooding and wildfires, there is a need for future researchers to continue to add to this body of knowledge beyond the three flood events and one wildfire examined here.

This dissertation also added to the available literature on disaster displacement from wildfire, which remains unfortunately scant. While the available body of work done in the wake of hurricanes like Katrina and Maria have been immensely helpful in framing this project, there is a continued need for additional research into wildfire events. The displacement determinants

uncovered in Chapters 3 and 4 of this work, especially the points of departure from typical displacement determinants in other disaster settings (Paul et al., 2024) demand additional examination by other researchers, perhaps in other American West wildfire settings. The singular effects of age and race on displacement uncovered in this work may be unique to Paradise and the Camp Fire, or may be replicated in other communities affected by wildland fire; I hope to collaborate with the hazards research community to help examine this association in other contexts.

The effect of former residents' perceptions about responsibility for the Camp Fire disaster was another novel theme explored in the survey work presented in Chapter 4. As wildfires continue to affect communities throughout the American West, more research is needed to further elucidate the connection between how residents process the disaster and their future residential preferences. This question becomes especially important within a context of climate gentrification, as those who acknowledge the reality of climate change's contribution to the event may be less likely to be willing to return to an area threatened by climate-driven hazards. While climate change belief was not predictive of residential preferences in this work, the fact that placing blame in "environmental / logging practices" was predictive of a preference to return to Paradise suggests that residents who attributed the disaster to more proximate causes (like local or state regulations) are more likely to return to threatened areas. This association is ripe for testing in other wildfire settings, especially in communities that are demographically, economically, and politically different from Paradise.

Finally, beyond the realm of theoretical work, there continues to be a need for practical, actionable data collection in the wake of wildfire disasters concerning basic needs, housing, and displacement. As noted by McConnell et al. (2024), wildfire displacement is "notably absent" in

reviews of disaster and environmental migration literature. While this work contributes by examining one notable wildfire disaster in great detail, much more research is needed to better understand other wildfire-affected communities. I call on other hazards researchers to continue examining the displacement effects from wildfires, including their social determinants. Recent destructive wildfires in Maui and again in northern California suggest further study.

Policy Implications

Financial and regulatory mechanisms often have the power to enable or discourage continued development into areas at high-risk of climate-driven floods and wildfires. Unfortunately, many policies exist at the national and state levels that continue to enable risky development in floodplains and fire hazard areas. In the flood realm, there is a persistent need to reform the National Flood Insurance Program to remove the perverse incentives that lead to continued reconstruction in high hazard areas and vast cross-subsidies across states and regions (Pinter et al., 2016). Alternatives or reforms to the NFIP that address these issues should also be explored by policy researchers, including community-based insurance or other mechanisms to better capitalize risk such premiums more accurately reflect the costs of developing and living in high-hazard areas (Kousky et al., 2021). Insurance is rapidly becoming a hot topic in the wildfire realm, as the State of California considers options for state-run or state-subsidized fire insurance (LeMee, 2024). California should proceed with caution to avoid the perverse incentives rife within programs such as the NFIP, and to avoid the entrenched tradition of regional subsidy of exurban fire risk so aptly described by Mike Davis' essay *The Case for Letting Malibu Burn* (1995). At the same time, public insurance programs should account for differential wealth,

income, and vulnerability, and consider that many wildland dwellers are perhaps not there by choice, but as a result of poverty and land scarcity. Many who survived the 2018 Camp Fire, as this dissertation shows, were in that group.

This leads to a broader call for continued advocacy for affordable housing in climate-safe communities. California communities have largely pursued an agenda of wildfire-ignorant development policies throughout its history (Fulton & Shigley, 2018), but it is time for wildfire to be taken more seriously in land use planning. A few promising developments have occurred in this direction, including a recent vote by the Los Angeles Board of Supervisors that struck down a proposed development in Tejon Ranch on the basis of wildfire risk (Sahagun, 2021). Some hazards researchers have described the post-disaster period as an opportune moment to reimagine hazard exposure and pursue better housing policies (Schumann et al., 2020) - however, this has largely not materialized. We have already seen households "double displaced" by wildfire in northern California. A recent LA Times article describes a family from Paradise who lost their home in the 2018 Camp Fire, relocated to the nearby wildland area of Cohasset, and then lost their new home in the 2024 Park Fire (Toohey, 2024).

To alleviate these issues, regulators should explore policies that, for example, might streamline or eliminate CEQA review for affordable housing in areas with little or no wildfire risk. More dramatic policy approaches might even include bills that would supersede local zoning in relatively climate-safe areas that are comprised of exclusionary, low-density zoning. This might especially be targeted at communities like Santa Cruz, whose exclusionary zoning policies contribute to the regional affordability crisis and continue to marginalize lower income populations into the fire-prone wildlands in the Santa Cruz Mountains (Greenberg, 2021). This work suggests that Chico, like Santa Cruz, might be a prime target for such legislation. Ending

single-family zoning may be the most important thing local governments can do both to combat climate change, and to curb wildland development (Thornton, 2024).

Finally, this work would be remiss to not address the seemingly insurmountable but gravely important topic of global climate change, which underpins the physical determinants of both flood and fire hazards. It would be difficult enough to mitigate flood and fire hazards given our current built environment in the American West without contending with changing underlying physical conditions, but climate change portends ever-worsening futures from the perspective of hazard vulnerability. Therefore, I call on citizens and planners throughout our corner of the world and beyond to redouble efforts toward carbon mitigation. The global mitigation of climate change might eventually bring about a more static level of hazard risk that would still be difficult, but not impossible, to plan for on a local level. I hope to dedicate my career as an academic and educator to pursuing these goals.

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APPENDICES

Appendix A – Survey Announcement

UC DAVIS
UNIVERSITY OF CALIFORNIA

Dear former (or current) Ridge resident,

You have been chosen to participate in our 2023 Ridge Residents Survey! This survey is intended for everyone who was affected by the Camp Fire, including those who may have left the region because of the fire. We (the research team) are both Butte County natives whose families lost homes in the fire, and we have dedicated our doctoral dissertations at UC Davis to understanding the lingering effects of the fire and hopefully helping prevent a disaster like this from happening again. A primary goal of this survey is to understand your housing situation and needs before and after the fire. We also ask about factors relating to your background, quality of life, job, commute, as well as opinions about risks and responsibilities related to the fire.

We understand that this is a sensitive topic for many people, but we would really appreciate your response, which should take no more than 10 minutes. By contributing to this survey, you are helping us ensure that the stories of all Paradise and Ridge residents – past and present - are being told as accurately as possible. To take the survey, you can navigate to the following URL – which you can also access by pointing to the following QR code using your mobile phone's camera*:

tinyurl.com/ridgesurvey2023 **OR:**

About the researchers:

Ryan Miller - rgmiller@ucdavis.edu
Ryan graduated from Paradise High School in 2008, and continued his studies at Chico State, where he graduated in 2012 with degrees in geography and economics. After leaving to earn a master's degree in urban planning in 2014, Ryan returned to Chico and has remained in the region ever since. Ryan teaches geography and social science at Chico State while also pursuing his PhD in geography at UC Davis. Ryan's mom and younger siblings lost their home in the fire.

Mitchell Snyder - mpsnyder@ucdavis.edu
Mitchell is a Butte County native whose father remains an elementary school teacher in Paradise (Evergreen 6th Grade) and whose family has lived on the Ridge for three generations. He attended Durham High School before attending UC Davis in 2011. After working at Enloe Medical Center for several years, he returned to UC Davis for Graduate School in 2018, where his father's experience during the Camp Fire have guided his interest in understanding how the fire has influenced Butte County.

*If you would prefer to complete this survey over the phone or by mail, please contact one of the researchers above at mpsnyder@ucdavis.edu or rgmiller@ucdavis.edu; or give us a call at: **530-433-8088**

Appendix B – Survey Questionnaire

Start of Block: Default Question Block

Intro Welcome to the 2023 Ridge Residents Survey! This survey is intended for everyone who was affected by the Camp Fire, including those who may have left the region as a result of the fire. A primary goal of this survey is to understand your housing situation and needs before and after the fire. Further, we hope to understand how and why some people have remained in the region and what is attracting newcomers to the area. We understand that this is still a sensitive topic for many people, and really appreciate your response.

Participating in this research survey should take about 10 minutes to complete. Doing so is voluntary and all responses are confidential; results will only be published in the aggregate, without connection to any individual.

You must be at least 18 years old to complete this survey.

We're going to ask you questions about the following things:

* Where you lived before the fire and where you live now
* Factors relating to your lifestyle and quality of life
* Employment and commute before and after the fire
* Opinions about risk and responsibility
* Some background information about you

Thanks so much for participating, we are looking forward to receiving your responses!

Ryan G. Miller, PhD Candidate, Geography Graduate Group, UC Davis (rgmiller@ucdavis.edu)
Mitch P. Snyder, PhD Candidate, Geography Graduate Group, UC Davis (mpsnyder@ucdavis.edu)

Page Break

1 On November 8th, 2018, were you living in an area affected by the Camp Fire?

- ○ Yes (1)
- ○ No (2)

Skip To: 2b If On November 8th, 2018, were you living in an area affected by the Camp Fire? = No

Skip To: 2 If On November 8th, 2018, were you living in an area affected by the Camp Fire? = Yes

Page Break

2 Do you ***currently*** live in an area that was affected by the Camp Fire?

- ○ Yes (1)
- ○ No (2)

Skip To: 3 If Do you currently live in an area that was affected by the Camp Fire? = Yes

Skip To: 3 If Do you currently live in an area that was affected by the Camp Fire? = No

Page Break

2b Do you ***currently*** live in an area that was affected by the Camp Fire?

- ○ Yes (1)
- ○ No (2)

Skip To: End of Survey If Do you currently live in an area that was affected by the Camp Fire? = No

Page Break

3 Which of the following best describes the community you lived in ***on November 8, 2018***:

- ○ Town of Paradise (1)
- ○ Upper Ridge (Magalia, Paradise Pines, Stirling City, etc.) (2)
- ○ Hwy 70 Communities (Concow, Yankee Hill, etc.) (3)
- ○ Butte Creek Canyon (4)
- ○ Chico (5)
- ○ Oroville (6)
- ○ Elsewhere in Butte County (7)
- ○ Outside Butte County (Still within CA) (8)
- ○ Outside of California (9)

Page Break

4 Which of the following best describes the community you ***currently*** live in:

- ○ Town of Paradise (1)
- ○ Upper Ridge (Magalia, Paradise Pines, Stirling City, etc.) (2)
- ○ Hwy 70 Communities (Concow, Yankee Hill, etc.) (3)
- ○ Butte Creek Canyon (4)
- ○ Chico (5)
- ○ Oroville (6)
- ○ Elsewhere in Butte County (7)
- ○ Outside Butte County (Still within CA) (8)
- ○ Outside of California (9)

Page Break

5 What is the ZIP code of your current address?

_____

Display This Question:

If Which of the following best describes the community you currently live in: = Elsewhere in Butte County

Or Which of the following best describes the community you currently live in: = Outside Butte County (Still within CA)

Or Which of the following best describes the community you currently live in: = Outside of California

6 What is the name of the Town or City where you currently live?

_____

Page Break

Display This Question:

If On November 8th, 2018, were you living in an area affected by the Camp Fire? = Yes

7 During the Camp Fire:

- ○ My residence was completely destroyed (1)
- ○ My residence was damaged (describe): (2) _____
- ○ My residence was unaffected (3)

Page Break

Q56 The next few questions ask you about your primary residence ***before*** the Camp Fire:

8 Before the Camp Fire, did you:

- ○ Own your residence (1)
- ○ Rent your residence (2)
- ○ Live with friends or family (rent free) (4)
- ○ Other (3)

9 Which of the following best describes your residence before the Camp Fire:

- ○ Stick-Built Home (1)
- ○ Mobile Home (2)
- ○ Apartment or Condominium (3)
- ○ Duplex or Triplex (4)
- ○ Other (5)

10 Before the Camp Fire, how much of your household's monthly income would you estimate was spent on housing?

- ○ Less than 10% (1)
- ○ 10-19% (2)
- ○ 20-29% (3)
- ○ 30-39% (4)
- ○ 40-49% (5)
- ○ 50% or more (6)

Page Break

Display This Question:

If On November 8th, 2018, were you living in an area affected by the Camp Fire? = Yes

11 About how many years did you live in ${3/ChoiceGroup/SelectedChoices} prior to November 8, 2018?

○ # of years (1) _____

12 Have you lived in ${3/ChoiceGroup/SelectedChoices} for most or all of your adult life?

○ Yes (1)

○ No (2)

Page Break

Q57 The next few questions ask you about your ***current*** primary residence:

13 Do you currently:

- ○ Own your residence (1)
- ○ Rent your residence (2)
- ○ Live with friends or family (rent free) (4)
- ○ Other (3)

14 Which of the following best describes your current residence:

- ○ Stick-Built Home (1)
- ○ Mobile Home (2)
- ○ Trailer or RV (8)
- ○ Apartment or Condominium (3)
- ○ Duplex or Triplex (4)
- ○ Other (5)

15 Currently, how much of your household's monthly income would you estimate is spent on housing?

- ○ Less than 10% (1)
- ○ 10-19% (2)
- ○ 20-29% (3)
- ○ 30-39% (4)
- ○ 40-49% (5)
- ○ 50% or More (6)

Page Break

Display This Question:

If On November 8th, 2018, were you living in an area affected by the Camp Fire? = No

And Do you currently live in an area that was affected by the Camp Fire? = Yes

16 What year did you move to ${4/ChoiceGroup/SelectedChoices}?

- ○ 2019 (1)
- ○ 2020 (2)
- ○ 2021 (3)
- ○ 2022 (4)
- ○ 2023 (5)

Page Break

Display This Question:

If On November 8th, 2018, were you living in an area affected by the Camp Fire? = Yes

And Have you lived in ${q://QID36/ChoiceGroup/SelectedChoices} for most or all of your adult life? = No

17a Thinking back to when you first moved to ${3/ChoiceGroup/SelectedChoices} did any of the following factors play a role? Select any/all that apply:

- ☐ Affordability (4)
- ☐ Attractive Climate / Environment (9)
- ☐ Employment (3)
- ☐ Family-Friendliness (11)
- ☐ Proximity to Family / Friends (5)
- ☐ Proximity to Nature / Outdoor Recreation (1)
- ☐ Privacy (2)
- ☐ School Quality (7)
- ☐ Social or Religious Community (8)
- ☐ Other (12)

Display This Question:

If On November 8th, 2018, were you living in an area affected by the Camp Fire? = Yes

And Have you lived in ${q://QID36/ChoiceGroup/SelectedChoices} for most or all of your adult life? = No

Carry Forward Selected Choices from "Thinking back to when you first moved to ${q://QID36/ChoiceGroup/SelectedChoices} did any of the following factors play a role? Select any/all that apply:"

17b You indicated that the following were factors related to your initial move to ${3/ChoiceGroup/SelectedChoices}. Please rank each factor from most important (top) to least important (bottom) by clicking and dragging each factor.

_____ Affordability (1)

_____ Attractive Climate / Environment (2)

_____ Employment (3)

_____ Family-Friendliness (4)

_____ Proximity to Family / Friends (5)

_____ Proximity to Nature / Outdoor Recreation (6)

_____ Privacy (7)

_____ School Quality (8)

_____ Social or Religious Community (9)

_____ Other (10)

Display This Question:

If Thinking back to when you first moved to ${q://QID36/ChoiceGroup/SelectedChoices} did any of the... = Other

17c In a few words, please describe the other factor(s) related to your move:

_____

Page Break

Display This Question:

If On November 8th, 2018, were you living in an area affected by the Camp Fire? = No

And Do you currently live in an area that was affected by the Camp Fire? = Yes

18a When you moved to ${4/ChoiceGroup/SelectedChoices} or the surrounding region in ${16/ChoiceGroup/SelectedChoices}, did any of the following factors play a role? Select any/all that apply:

- ☐ Affordability (4)
- ☐ Attractive Climate / Environment (9)
- ☐ Employment (3)
- ☐ Family-Friendliness (11)
- ☐ Proximity to Family / Friends (5)
- ☐ Proximity to Nature / Outdoor Recreation (1)
- ☐ Privacy (2)
- ☐ School Quality (7)
- ☐ Social or Religious Community (8)
- ☐ Other (12)

Display This Question:

If On November 8th, 2018, were you living in an area affected by the Camp Fire? = No

And Do you currently live in an area that was affected by the Camp Fire? = Yes

Carry Forward Selected Choices from "Thinking back to when you first moved to ${q://QID36/ChoiceGroup/SelectedChoices} did any of the following factors play a role? Select any/all that apply:"

18b You indicated that the following were factors related to your move to ${4/ChoiceGroup/SelectedChoices}. Please rank each factor from most important (top) to least important (bottom) by clicking and dragging each factor.

_____ Affordability (1)

_____ Attractive Climate / Environment (2)

_____ Employment (3)

_____ Family-Friendliness (4)

_____ Proximity to Family / Friends (5)

_____ Proximity to Nature / Outdoor Recreation (6)

_____ Privacy (7)

_____ School Quality (8)

_____ Social or Religious Community (9)

_____ Other (10)

Display This Question:

If When you moved to ${q://QID37/ChoiceGroup/SelectedChoices} or the surrounding region in ... = Other

18c In a few words, please describe the other factor(s) related to your move:

_____

Display This Question:

If Do you currently live in an area that was affected by the Camp Fire? = No

And Do you currently live in an area that was affected by the Camp Fire? = Yes

19 In a brief sentence, please describe what brought you to ${4/ChoiceGroup/SelectedChoices} ?

_____

Page Break

Display This Question:

If During the Camp Fire: = My residence was completely destroyed

Or During the Camp Fire: = My residence was damaged (describe):

And If

Do you currently live in an area that was affected by the Camp Fire? = Yes

20a You indicated that your residence was damaged or destroyed by the Camp Fire. Did any of the following factors influence you to remain and/or rebuild?

- ☐ Affordability (4)
- ☐ Attractive Climate / Environment (9)
- ☐ Employment (3)
- ☐ Family-Friendliness (11)
- ☐ Proximity to Family / Friends (5)
- ☐ Proximity to Nature / Outdoor Recreation (1)
- ☐ Privacy (2)
- ☐ School Quality (7)
- ☐ Social or Religious Community (8)

Display This Question:

If During the Camp Fire: = My residence was completely destroyed

Or During the Camp Fire: = My residence was damaged (describe):

And If

Do you currently live in an area that was affected by the Camp Fire? = Yes

Carry Forward Selected Choices from "You indicated that your residence was damaged or destroyed by the Camp Fire. Did any of the following factors influence you to remain and/or rebuild?"

20b You indicated that the following factors influenced you to remain and/or rebuild in ${4/ChoiceGroup/SelectedChoices}. Please rank each factor from most important (top) to least important (bottom) by clicking and dragging each factor.

_____ Affordability (1)

_____ Attractive Climate / Environment (2)

_____ Employment (3)

_____ Family-Friendliness (4)

_____ Proximity to Family / Friends (5)

_____ Proximity to Nature / Outdoor Recreation (6)

_____ Privacy (7)

_____ School Quality (8)

_____ Social or Religious Community (9)

Display This Question:

If During the Camp Fire: = My residence was completely destroyed

Or During the Camp Fire: = My residence was damaged (describe):

And If

Do you currently live in an area that was affected by the Camp Fire? = No

Q20a_displaced You indicated that your residence was damaged or destroyed by the Camp Fire. Did any of the following factors influence your relocation to the community where you currently live?

- [ ] Affordability (4)
- [ ] Attractive Climate / Environment (9)
- [ ] Employment (3)
- [ ] Family-Friendliness (11)
- [ ] Proximity to Family / Friends (5)
- [ ] Proximity to Nature / Outdoor Recreation (1)
- [ ] Privacy (2)
- [ ] School Quality (7)
- [ ] Social or Religious Community (8)

Page Break

Display This Question:

If During the Camp Fire: = My residence was completely destroyed

Or During the Camp Fire: = My residence was damaged (describe):

And If

Do you currently live in an area that was affected by the Camp Fire? = No

Carry Forward Selected Choices from "You indicated that your residence was damaged or destroyed by the Camp Fire. Did any of the following factors influence your relocation to the community where you currently live?"

Q20b_displaced You indicated that the following factors influenced your relocation to the community where you currently live. Please rank each factor from most important (top) to least important (bottom) by clicking and dragging each factor.

_____ Affordability (1)

_____ Attractive Climate / Environment (2)

_____ Employment (3)

_____ Family-Friendliness (4)

_____ Proximity to Family / Friends (5)

_____ Proximity to Nature / Outdoor Recreation (6)

_____ Privacy (7)

_____ School Quality (8)

_____ Social or Religious Community (9)

Display This Question:

If During the Camp Fire: = My residence was completely destroyed

Or During the Camp Fire: = My residence was damaged (describe):

And If

Do you currently live in an area that was affected by the Camp Fire? = Yes

20c Please describe what the rebuilding / repair process was like for you (if applicable):

_____

Page Break

21 Thinking back to the community where you lived ***before*** the fire, how would you characterize the following aspects of that community?

	Extremely bad (1)	Somewhat bad (2)	Neither good nor bad (3)	Somewhat good (4)	Extremely good (5)
Cost of Living (1)	○	○	○	○	○
Community (2)	○	○	○	○	○
Environment (3)	○	○	○	○	○
Location / Convenience (4)	○	○	○	○	○
Public Safety (5)	○	○	○	○	○
Overall quality of life (6)	○	○	○	○	○

Page Break

22 As of today, how would you characterize the following aspects of the community where you **currently** live?

	Extremely bad (1)	Somewhat bad (2)	Neither good nor bad (3)	Somewhat good (4)	Extremely good (5)
Cost of Living (1)	○	○	○	○	○
Community (2)	○	○	○	○	○
Environment (3)	○	○	○	○	○
Location / Convenience (4)	○	○	○	○	○
Public Safety (5)	○	○	○	○	○
Overall quality of life (6)	○	○	○	○	○

Page Break

23 In general, what do you feel your risk level is for the following:

	Low (1)	Somewhat low (2)	Moderate (3)	Somewhat high (4)	High (5)
Car Crashes (1)	○	○	○	○	○
Crime (2)	○	○	○	○	○
COVID-19 (3)	○	○	○	○	○
Earthquakes (4)	○	○	○	○	○
Fires (5)	○	○	○	○	○
Floods (6)	○	○	○	○	○

Page Break

24 Please indicate your level of agreement with the following statements:

	Strongly disagree (1)	Somewhat disagree (2)	Neither agree nor disagree (3)	Somewhat agree (4)	Strongly agree (5)
I am confident about my ability to handle wildfires (1)	○	○	○	○	○
I wish I could live in a safer location (2)	○	○	○	○	○
Wildfire risk affects my decisions (3)	○	○	○	○	○
Living in a house with a yard is important to me (4)	○	○	○	○	○
I think about wildfires often (5)	○	○	○	○	○
My community supports my well-being and safety (6)	○	○	○	○	○
Living on the Ridge is part of my identity (7)	○	○	○	○	○

I feel a sense of belonging in my community (8)	○	○	○	○	○
I want to live where I am now for the rest of my life (9)	○	○	○	○	○

Page Break

Q49 Next, we're going to ask you a few questions about your employment and commute before and after the Camp Fire.

25 Thinking back to the time period immediately before the Camp Fire, were you employed in a position that required you to commute to a workplace outside the home?

- ○ Yes (1)
- ○ No (2)

Skip To: 30 If Thinking back to the time period immediately before the Camp Fire, were you employed in a positio... = No

26 What city or town did you commute to for this job? If working across multiple job sites, choose the city or town you commuted to most often.

_____

27 How did you usually commute to this job?

- ○ Drove Alone (1)
- ○ Drove with Others (carpooled) (2)
- ○ Took Public Transportation (3)

- ○ Biked or Boarded (4)
- ○ Walked (5)

28 How long did it typically take for you to get to work?

- ○ Less than 5 minutes (1)
- ○ 5-9 minutes (2)
- ○ 10 - 14 minutes (3)
- ○ 15 - 19 minutes (4)
- ○ 20 - 29 minutes (5)
- ○ 30 - 39 minutes (6)
- ○ 40 - 49 minutes (7)
- ○ 50 - 59 minutes (8)
- ○ 1 hour - 2 hours (9)
- ○ More than 2 hours (10)

Page Break

29 Are you still employed in the same position you held immediately prior to the Camp Fire?

- Yes (1)
- No (2)

Display This Question:

If Are you still employed in the same position you held immediately prior to the Camp Fire? = Yes

Q66 Has your commute changed since the Camp Fire?

- Yes (1)
- No (2)

Skip To: 34 If Has your commute changed since the Camp Fire? = No

Skip To: 33 If Has your commute changed since the Camp Fire? = Yes

30 Are you **currently** employed in a position that requires you to commute outside the home?

- Yes (1)
- No (2)

Skip To: 34 If Are you currently employed in a position that requires you to commute outside the home? = No

31 What city or town do you commute to for this job? If working across multiple job sites, choose the city or town you commute to most often.

_____

32 How do you usually commute to this job?

- ○ Drive Alone (1)
- ○ Drive with Others (carpool) (2)
- ○ Take Public Transportation (3)
- ○ Bike or Board (4)
- ○ Walk (5)

33 How long does it typically take for you to get to work?

- ○ Less than 5 minutes (1)
- ○ 5-9 minutes (2)
- ○ 10 - 14 minutes (3)

- ○ 15 - 19 minutes (4)
- ○ 20 - 29 minutes (5)
- ○ 30 - 39 minutes (6)
- ○ 40 - 49 minutes (7)
- ○ 50 - 59 minutes (8)
- ○ 1 hour - 2 hours (9)
- ○ More than 2 hours (10)

Page Break

34 In your opinion, how responsible were each of the following in contributing to the Camp Fire disaster?

	Not at all responsible (1)	Somewhat responsible (2)	Very responsible (3)
Climate change (1)	○	○	○
Environmental / logging policies (2)	○	○	○
Land use / housing policies (3)	○	○	○
Local government decisions (4)	○	○	○
Pacific Gas and Electric (PG&E) (5)	○	○	○
Wildfire fighting practices (6)	○	○	○

Page Break

Q53 Thanks so much for your time so far. Lastly, we have a few final questions about you:

35 Please tell us your age on your last birthday:

_____

Q62 Including yourself, how many people live in your household?

_____

36 What is the highest level of formal education you have completed?

- Some School; No Diploma or GED (1)
- High School Diploma / GED (2)
- Some College (3)
- Associate's or other Technical Degree (4)
- Bachelor's Degree (5)
- Graduate Degree (6)

37 Which of the following describes you (select any/all that apply):

- [ ] White (1)
- [ ] Hispanic or Latino (2)
- [ ] Black or African American (3)
- [ ] American Indian or Alaska Native (4)
- [ ] Asian (5)
- [ ] Native Hawaiian or Pacific Islander (6)
- [ ] Mixed / Multiple (7)

38 Which best describes you?

- ○ Male (1)
- ○ Female (2)
- ○ Non-binary / third gender (3)
- ○ Prefer not to say (4)

Display This Question:

If Do you currently live in an area that was affected by the Camp Fire? = No

39 Under ideal circumstances, would you return to ${3/ChoiceGroup/SelectedChoices}?

- ○ Yes (1)
- ○ Maybe (2)
- ○ No (3)

Display This Question:

If Under ideal circumstances, would you return to ${q://QID36/ChoiceGroup/SelectedChoices}? = Yes

Or Under ideal circumstances, would you return to ${q://QID36/ChoiceGroup/SelectedChoices}? = Maybe

40 What would need to be different in order for you to return to ${3/ChoiceGroup/SelectedChoices}?

_____

_____

_____

_____

_____

41 Is there anything else you would like to share about your experiences?

_____

_____

_____

_____

_____

Q63 How did you learn about this survey?

- ○ Saw online or in a social media post (1)
- ○ Received an invitation letter through the mail (2)
- ○ Sent to me by someone I know (3)
- ○ Other (4)

42 May we contact you about your responses, and/or to ask for additional feedback on future surveys related to this topic?

- ○ Yes (1)
- ○ No (2)

Display This Question:

If May we contact you about your responses, and/or to ask for additional feedback on future surveys... = Yes

43 Please enter your email below so that we may contact you in the future. This will not be used for any other purpose or solicitation.

_____

End of Block: Default Question Block