

## **Wildfire Risk in the Wildland-Urban Interface: Measuring Impacts, Modeling Choices, Evaluating Policies**

Since the nineteen seventies, wildfire activity in the western US, and damages caused by wildfires, have increased dramatically (Westerling 2016; Williams et al. 2018). In California, ten of the twenty most destructive fires in state history have occurred in the past five years, including 2018's Camp Fire which destroyed more than 18,000 structures in Paradise, California and surrounding communities (CalFire 2019; Garcia 2018). Among several factors that have contributed to increasing wildfire damages is significant exposure to wildfire risk within wildland-urban interface (WUI) communities, developed areas that are directly adjacent to or interspersed with large areas of wildland vegetation. In many parts of the western US, WUI communities face increasing wildfire risk due to upward trends in both wildfire activity and residential development in WUI areas (Radeloff et al. 2018).

These increases in risk have led to a variety of problems and difficult decisions for policymakers. Communities are confronting whether and how to allow further residential development in high wildfire hazard areas (Barrett 2019). For homeowners in these areas, insurance premiums have ballooned, and in some cases, it has become difficult to find insurers willing to continue offering policies (Cignarele et al. 2018; Flavelle 2019). Increased exposure to wildfire risk also increases costs for electric utilities—who may be held liable when their equipment is at fault in igniting a fire—and, ultimately, for electricity consumers (Penn 2019). Increased wildfire risk also increases costs for federal and state agencies tasked with managing wildfire incidents, especially as evidence suggests that suppression effort is greater for fires that burn near homes (Liang et al. 2008; Baylis and Boomhower 2019, Plantinga, Walsh and Wibbenmeyer 2020).

RFF proposes a project intended to improve understanding of wildfire risk in the wildland-urban interface, and how exposure to wildfire risk in the WUI is likely to change under a variety of policy scenarios. In the first stage of the project, we provide important context regarding wildfire policy in the wildland-urban interface by assessing the degree to which wildfire risk is borne by relatively low versus relatively high-income households. In the second stage of the project, in order to better understand potential effects of wildfire risk policies in the wildland-urban interface, we analyze how households trade-off price, amenities, and wildfire risk in choosing where to live.

### **1. Evaluating the Distributional Incidence of Wildfire Risk**

Popular understanding of the distributional incidence of wildfire risk is frequently contradictory. News stories highlight impacts of fire on wealthy residents of high-amenity, high fire hazard areas, including celebrities like Ellen Degeneres and Miley Cyrus, and they simultaneously emphasize impacts on vulnerable rural communities like Paradise, California. Yet while perceptions regarding who is in harm's way frequently underlie attitudes regarding wildfire policy, existing scholarship has not clearly documented the distributional incidence of wildfire risk. Merging county assessors' data and Census data with data describing the spatial distribution of wildfire hazard, we will assess how distributions of wealth, income, and other demographic variables vary between high wildfire hazard areas and areas without high fire hazard.

Existing scholarship has done little to clarify understanding of the distributional incidence of wildfire risk. While several studies have overlaid measures of social vulnerability derived from Census data with spatial data describing wildfire hazard (e.g. Wigtil et al. 2016, Davies et al. 2018), these studies have generally studied the relationship between wildfire hazard and social vulnerability at national or broad regional scales, masking variation at finer scales.

RFF will use property-level assessors' data from Zillow.com, as well as block group-level Census data, together with spatial wildfire hazard data to provide a more complete description of the social incidence of wildfire risk than has yet been provided. We will document to what extent wildfire risk is borne by owners of high-value versus low-value properties within each western US state. Similarly, using Census data, we will document whether wildfire risk disproportionately affects non-whites and older people.

This research will provide policymakers, especially those assigned to manage wildfire risks and those concerned with the health and viability of rural communities, as well as the general public, with baseline data about the WUI, which is currently unavailable. The findings should be useful to state policymakers as they consider policy options for reducing wildfire risks and their likely impacts on households living in rural communities. If policies raise the costs of living in the WUI, for example, will relatively poorer households or wealthier households mainly be harmed? Right now, information to even provide a first-order answer to this question is limited; our analysis should fill these gaps.

## 2. Household Sorting over Wildfire Risk

As wildfire activity increases, costs of living in high wildfire hazard areas are expected to increase, both as costs of wildfire risk trickle down to homeowners (as through increases in insurance premiums), and due to policies expressly targeted toward reducing wildfire risk. Examples of the latter include building codes and land use laws, as well as policies that are, at least in part, intended to disincentivize further development in high wildfire risk areas, such as wildfire fees and utility rate differentials.

However, it is unclear how cost-of-living increases will affect household welfare, household decisions regarding whether to live in a high wildfire hazard area (what economists refer to as "sorting" decisions), and who lives in these areas. How such policies will shape the future of the wildland-urban interface depends on the extent to which households are willing to trade increased cost-of-living for the amenities associated with living in high fire hazard areas, and which households are willing to make that trade.

To address these questions, RFF proposes to provide the first study of household sorting over wildfire risk. We will use data regarding property sales from Zillow.com, merged with anonymized borrower data from the Home Mortgage Disclosure Act data set, within a discrete choice modeling framework in order to understand household decisions with respect to wildfire risk. Our study will use a modern discrete choice modeling framework that allows household preferences over property characteristics, amenities, and wildfire risk to vary across household types. We will account for endogeneity of home prices to unobserved property and neighborhood characteristics using a well-established instrumental variables strategy developed by Bayer and Timmins (2007). We will address endogeneity of wildfire hazard to unobserved amenities with a quasi-experimental approach using changes in perceptions of wildfire hazard in the wake of large damaging wildfire incidents (McCoy and Walsh 2018, Wibbenmeyer et al. 2019).

While there is some limited evidence available regarding the effects of amenities correlated with fire hazard on property values (Stetler et al. 2010), and economists have used sorting models to study a variety of environmental amenities and disamenities (Kuminoff, Smith and Timmins 2013, such models have not yet been applied to the study of wildfire hazard within the WUI. Our model will allow us to provide the first analysis of how demographics within the WUI are likely to change as risk and cost-of-living increase. For example, insurance prices affect the costs of living in the WUI and will affect location of different households on the landscape. When a local government institutes zoning changes or defensible space regulations, this will affect house prices, which in turn will affect the location of different households on the landscape. If a state agency or the US Forest Service invests in activities such as thinning and fire treatments that lower wildfire risks, this will also affect household decisions about where to locate. Ideally, these policies will have their intended effects of

lowering risks and the costs of wildfires. Our model results will reveal the extent to which we can expect that to happen and to what extent policies will result in shifts in the distribution of burden across households of different income levels.

### 3. Products, Communications, and Policy Engagement

We anticipate several written outputs from the project. We anticipate at least three peer-reviewed research papers—one on the baseline results (part 1) and two from the locational sorting model and policy simulation results from the model (part 2). We expect to present our research findings at applied economics conferences such as the Association of Environmental and Resource Economists (AERE) and Agricultural and Applied Economics Association (AAEA) annual meetings and possibly also at the American Planning Association's annual Policy and Advocacy Conference and an international fire conference, such as the International Association of Wildland Fire's Fire and Climate Conference. Finally, Resources for the Future has a number of publication outlets for policy and lay audiences. We expect an article in Resources magazine, posts on the Common Resources blog, and at least one podcast in the popular Resources Radio podcast series. We will share these outputs (including journal articles and Resources for the Future publications) and insights from our analysis with our contacts within agencies and local communities.

RFF is one of the few organizations that is entrusted to bring together diverse stakeholders and apply a balanced economic lens to critical environmental policy issues. RFF's research is designed to elucidate and quantify issues that decisionmakers care about, re-shape the way decisionmakers and the public think about problems, and convene stakeholders to develop a shared understanding of issues, and find common ground. For example, a [recent Resources article](#) examined the implications for wildfire risk management of analogous approaches to coastal flooding risk. Another [RFF working paper](#) last year demonstrated that federal agencies can save up to \$7.7 million per year in post-fire costs by using satellite imagery to prioritize response measures. Recently in other forestry related work, RFF has also provided input for the staff of Representative Westerman (R-AR) as they were developing the legislation known as the [Trillion Trees Act, and has held multiple events](#), including a [panel discussion](#) this February, that explored the potential for forests and forest products in carbon sequestration.

## Attachment 1: Key Personnel

**Matthew Wibbenmeyer, Fellow** . Matthew Wibbenmeyer's research seeks to understand important factors that influence administration of environmental management and to use this understanding to inform improved policy. With a focus on forest and land management, he is interested in how actions and interactions among government and individuals determine management outcomes. He has a PhD in economics from the University of California, Santa Barbara, and a Master's in Resource Conservation from the University of Montana.

**Margaret Walls, Senior Fellow.** Margaret Walls's current research focuses on issues related to resilience and adaptation to extreme events, ecosystem services, and conservation, parks and public lands. For example, Walls's work on flood resilience assesses the factors that affect household location decisions in coastal areas, how individuals perceive flood risks, and how risk perceptions affect adaptation decisions. Walls has also written extensively on parks and conservation funding, including options for the U.S. national park system and state parks. She has a PhD in economics, University of California, Santa Barbara.

## References

- Barrett, K. "Reducing Wildfire Risk in the Wildland-Urban Interface: Policy, Trends, and Solutions." *Idaho L. Rev.* 55 (3).
- Bayer, P., & Timmins, C. (2007). Estimating equilibrium models of sorting across locations. *The Economic Journal*, 117(518): 353-374.
- Baylis, P., & Boomhower, J. (2019). Moral hazard, wildfires, and the economic incidence of natural disasters. *National Bureau of Economic Research Working Paper Series*, No. w26550.
- CalFire 2019. "Top 20 Most Destructive California Wildfires". Available online at [https://www.fire.ca.gov/media/5511/top20\\_destruction.pdf](https://www.fire.ca.gov/media/5511/top20_destruction.pdf) [accessed May 19, 2020].
- Cignarele, T., Laucher, J., Allen, K., & Landsman-Smith, L. (2018). *The Availability and Affordability of Coverage for Wildfire Loss in Residential Property Insurance in the Wildland-Urban Interface and Other High-Risk Areas of California: CDI Summary and Proposed Solutions*. Report prepared by California Department of Insurance's Availability and Affordability of Residential Property Insurance Task Force.
- Davies, I. P., Haugo, R. D., Robertson, J. C., & Levin, P. S. (2018). The unequal vulnerability of communities of color to wildfire. *PLoS one*, 13(11).
- Flavelle, C. (2019). "As wildfires get worse, insurers pull back From riskiest areas." *The New York Times*, August 20, 2019.
- Garcia, Sandra E. 2018. "Camp Fire is 100 percent contained, California officials say." *The New York Times*, November 25.
- Liang, J., Calkin, D.E., Gebert, K.M., Venn, T.J., & Silverstein, R.P. (2008). Factors influencing large wildland fire suppression expenditures. *International Journal of Wildland Fire*, 17(5): 650-659.
- Kuminoff, N., Smith, V.K. & Timmins, C. (2013). The new economics of equilibrium sorting and policy evaluation using housing markets. *Journal of Economic Literature*, 51(4): 1007-1062.
- McCoy, S.J., & Walsh, R.P. (2018). Wildfire risk, salience & housing demand. *Journal of Environmental Economics and Management*, 91: 203-228.
- Penn, I. (2019). "Blamed for wildfires, PG&E seeks higher electricity rates." *The New York Times*. April 23.
- Plantinga, A.P., Walsh, R., Wibbenmeyer, M. (2020). Endogenous adaptation to natural disasters: Wildfires and wildfire suppression. Working paper.
- Radeloff, V.C., Helmers, D.P., Kramer, H.A., Mockrin, M.H., Alexandre, P.M., Bar-Massada, A., Butsic, V. et al. (2018). Rapid growth of the US wildland-urban interface raises wildfire risk. *Proceedings of the National Academy of Sciences*, 115(13): 3314-3319.
- Stetler, K.M., Venn, T.J., & Calkin, D.E. (2010). The effects of wildfire and environmental amenities on property values in northwest Montana, USA. *Ecological Economics*, 69(11), 2233-2243.
- Westerling, A.L. (2016). Increasing western US forest wildfire activity: Sensitivity to changes in the timing of spring. *Philosophical Transactions of the Royal Society B*, 371(1696).
- Wibbenmeyer, M, Anderson, S.E. & Plantinga, A.J. (2019). Salience and the government provision of public goods. *Economic Inquiry*, 57(3): 1547-1567.

Wigtil, G., Hammer, R.B., Kline, J.D., Mockrin, M.H., Stewart, S.I., Roper, D., & Radeloff, V.C. (2016). Places where wildfire potential and social vulnerability coincide in the coterminous United States. *International Journal of Wildland Fire*, 25(8): 896-908.

Williams, A.P., Abatzoglou, J.T., Gershunov, A., Guzman-Morales, J., Bishop, D.A., Balch, J.K., & Lettenmaier, D.P. (2019). Observed impacts of anthropogenic climate change on wildfire in California. *Earth's Future*, 7: 892–910.