A Research Paper by

HEADWATERS
ECONOMICS

Wildfire & Vulnerable Populations
in Austin, Texas

Report and User Guide

September 2018

Wildfire & Vulnerable Populations in Austin, Texas

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ABOUT HEADWATERS ECONOMICS

Headwaters Economics is an independent, nonprofit research group whose mission is to improve community development and land management decisions.

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ABOUT THIS REPORT

This is a companion report to the interactive, online Austin Wildfire and Vulnerable Populations Tool. This report provides background information and helps interpret findings. We encourage you to visit and interact with the tool while reading this report.

The Austin Wildfire and Vulnerable Populations tool can be found at https://headwaterseconomics.org/wildfire/homes-risk/austin-wildfire-population-risk.
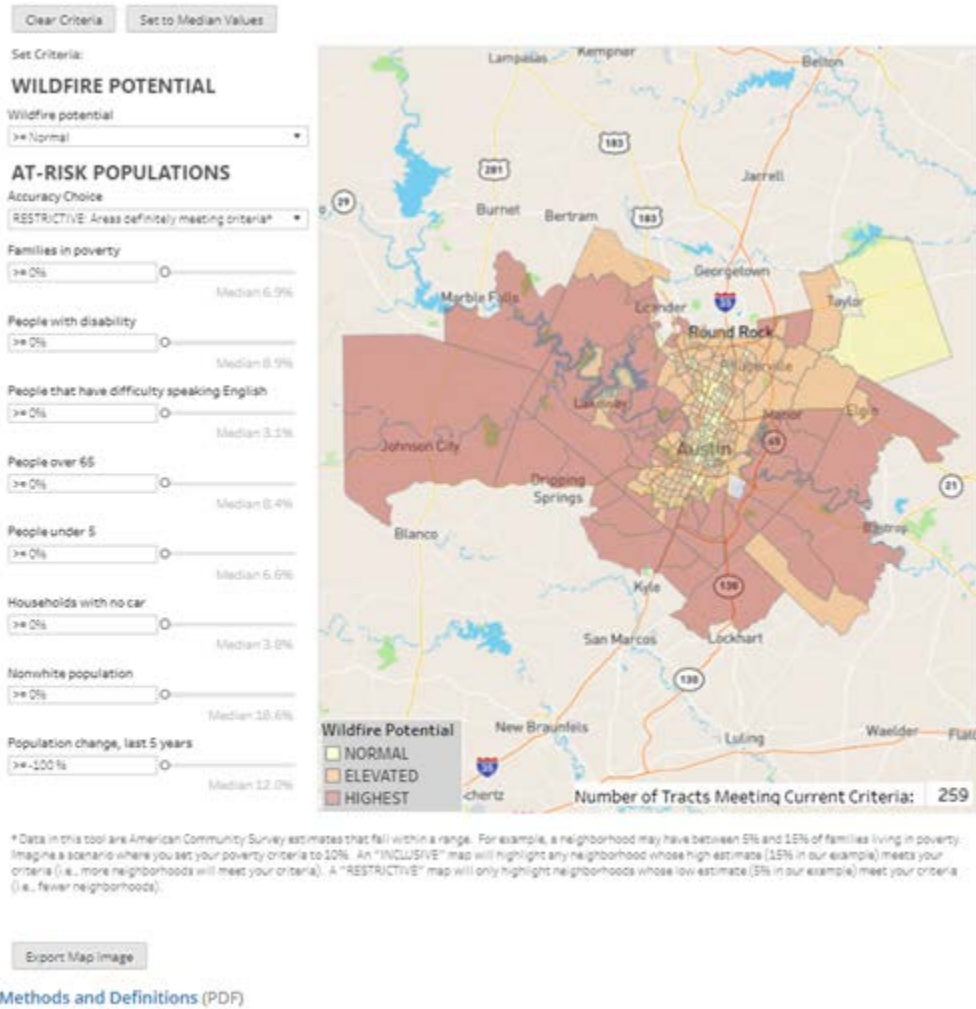
EXECUTIVE SUMMARY

With warmer, drier wildfire seasons and significant population growth in the wildland-urban interface, fire risk in Austin, Texas is increasing. Wildfire potential exists not just in the more forested portions of west Austin, but all around the city. Though they may exhibit less intensity than west-side crown fires, east-side grass and shrub fires can move extremely fast and pose significant threats to human health and safety, buildings, infrastructure, and water quality.

Austin's most vulnerable populations largely are concentrated on the east side, a result of early 20th-century segregation policy and the legacy of discriminatory practices. Like other disasters, wildfires disproportionately affect the most vulnerable populations who are more likely to experience adverse outcomes because of their socioeconomic status, race, ethnicity, and age. Vulnerable populations are more likely to lack resources to prepare for, respond to, and recover from disasters, and they may experience cultural and institutional barriers, have limited mobility, and have compromised physical health.

To reduce the susceptibility and increase the resiliency of Austin's residents to wildfire, it is important to understand the spatial patterns of wildfire threats and vulnerable populations. Headwaters Economics created the free, online, interactive Austin Wildfire & Vulnerable Populations Tool to help identify areas of overlapping threats and vulnerabilities. The tool uses data from the Austin and Travis County Community Wildfire Protection Plan (CWPP), U.S. Census, and U.S. Centers for Disease Control and Prevention.

The tool highlights areas of overlapping vulnerability. For example, areas of highest population growth over the last five years nearly all have higher wildfire threat. Wildfire risk intersects with more people who lack proficiency with English, more families in poverty, and more children under the age of five in east Austin. A few key east-side neighborhoods exhibit multiple intersecting vulnerabilities that are compounded by higher wildfire threat.

Information from the Austin Wildfire & Vulnerable Populations Tool is designed to support land use planners, fire personnel, elected officials, community health organizations, disaster response organizations, and others to:
- Prioritize and direct resources to neighborhoods where vulnerabilities may make it more difficult to prepare for, respond to, or recover from wildfire.
- Target education and outreach to areas most at risk from wildfire and with the most at-risk people, based on demographics and wildfire threats.
- Customize education and outreach materials in multiple languages for neighborhoods that have low English proficiency and are at risk to wildfire.
- Tailor wildfire response and operational plans for specific neighborhoods. For example, portions of the city with a higher proportion of disabled, elderly, or young residents may require different evacuation, emergency housing, and recovery plans.

Austin's vision of being a resilient and adaptive city requires a robust understanding of the community's susceptibility to wildfire risk and detailed vulnerability assessments.[1] This tool can help deepen understanding of where and how Austin's most vulnerable populations are at the greatest risk to wildfire.

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[1] Austin, Texas Climate Resilience Action Plan. April 2018. Available at
http://austintexas.gov/sites/default/files/files/Sustainability/Climate_Resilience_Action_Plan.compressed.pdf

I: BACKGROUND

Based on climate projections, Austin, Texas is expected to experience hotter summers and more frequent drought in the future, leading to increased wildfire risk.[1] Combined with rapid population growth as one of the U.S.'s fastest-growing cities, the potential impacts can have severe consequences on the safety, health, and quality of life of Austin's citizens. These threats are likely to disproportionally affect the most vulnerable populations, as they have fewer resources to mitigate threats, respond during disasters, and recover after wildfire events.

Wildfire Potential Across Austin

Austin is no stranger to the threats of wildfire. On Labor Day weekend in 2011, wildfires burned more than 7,000 acres and destroyed 57 homes. In neighboring Bastrop County the same weekend, wildfires consumed more than 340,000 acres, destroying 1,700 homes. In response, Austin and Travis County formed a Joint Wildfire Task Force and developed a Community Wildfire Protection Plan (CWPP) to strengthen wildfire preparation, response, and resilience.[2]

A component of the 2014 CWPP was a complete risk assessment for the greater Austin area based on the best available data and science, taking into consideration factors such as weather, topography, and fuels. The assessment provides a consistent way of examining relative risk across the greater Austin area.

The wildfire assessment shows that wildfire potential is significant across large portions of Austin, generally increasing in severity toward the city fringe (Figure 1.1). Contrary to conventional understanding, wildfire does not just threaten the more forested areas predominantly on the west side of the city, but also affects the east side with grass- and shrubland vegetation types.
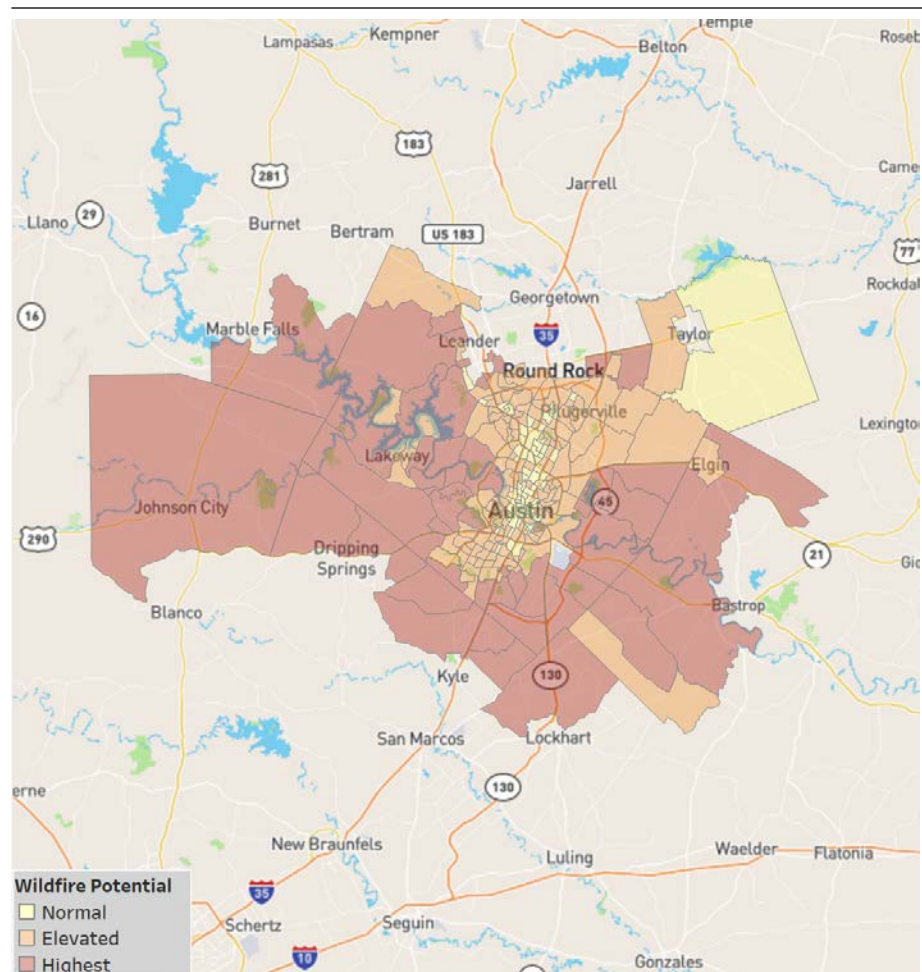

Figure 1.1 Wildfire potential, summarized to the census tract. Wildfire potential is a measure of wildfire risk and is derived from the Austin and Travis County CWPP.

Grass and shrub vegetation on Austin's eastern edges can carry fast-moving wildfires that can threaten lives and public safety, cause damage to buildings and infrastructure, and impact water quality. Although fire intensity (or flame length) may be less than in a forested area where fires can move into the crowns of trees, grass and shrub fires still have dangerous consequences. Grass and shrub fires have much faster rates of spread and under dry, windy conditions can be extremely difficult to control. They produce large amounts of radiant heat that can severely injure and kill people in its path. Grassfires create less ember cast

Figure 1.2. A fast-moving grass fire approaches a north Texas community in January 2018. Grass fires have faster rates of spread than forest fires, creating dangerous situations for evacuation and fire fighters.

(also called "firebrands") than crown fires, but once a grassfire ignites a structure, embers from the burning structure (such as insulation, roofing, and siding) can travel many kilometers and ignite new spot fires well ahead of the fire front. Due to the finer nature of the fuels, grassfires can also be more easily ignited by sparks from machinery, hot exhaust from vehicles, and other accidental sources.

Tragic grassland fires in 2017 in Texas, Kansas, and Oklahoma killed seven people, burned more than two million acres, killed thousands of livestock, and destroyed outbuildings, pasture, and ranch infrastructure. Some of the fires moved as quickly as 70 miles per hour, giving people little time to escape.[3] As of the writing of this report, the 2018 wildfire season was on track to be extreme for Texas, with numerous grassfires exacerbated by hot temperatures and dry conditions one of the core causes.[4]

Across the U.S., extreme and erratic wildfire behavior, bigger fires, and longer fire seasons can be partly blamed on climate trends of warmer, drier conditions that dry out fuels, warmer overnight temperatures that don't reprieve fire activity overnight, and longer growing seasons that allow for greater fuel accumulation.[5,6]

The worsening wildfire trends are amplified by the influx of people in fire-prone landscapes. Populations in the wildland-urban interface—the area where housing and burnable vegetation meet or intermingle—are growing faster than in any other land use type in the United States.[7] More people in these landscapes means more fires started; human-ignited wildfires now account for 84 percent of all U.S. wildfires. People are causing wildfires in places and during times of the year that would not typically occur, effectively tripling the length of the fire season.[8]

Vulnerable People and Differential Susceptibility

People's susceptibility to wildfire is based on their ability to prepare for, respond to, and recover from a wildfire.[9] The capacity to cope with disasters is largely rooted in social, economic, and political structures from which vulnerable populations may be marginalized or systematically excluded.[10] Vulnerable populations are more likely to be disproportionately affected by natural disasters because they lack resources, experience cultural and institutional barriers, have limited mobility, and have compromised physical health. Table 1.1 summarizes some of the ways different vulnerable populations are susceptible to wildfire.

Table 1.1: Vulnerable Populations & Susceptibility to Wildfire	
Population[a]	**Susceptibility to Wildfire**
Families in Poverty	Low income is one of the strongest predictors for compromised health and ability to recover from disruptions.[11] Wildfires disproportionately affect the poor because of factors such as inadequate housing, social exclusion, a diminished ability to evacuate or relocate, and more acute emotional stress. Low-income people are also more likely to be overlooked during emergency response following disasters,[12] and are less likely to have adequate property insurance, so they bear a greater burden from property damage following wildfires.[13] Due to a lack of financial resources and time, impoverished families may be less likely to take proactive measures to mitigate wildfire hazard in advance of an event.[14]
Disabled people	Disabled populations are subject to health complications that make wildfire more consequential since disasters often result in limited access to medical care.[15] Compromised mobility and medical conditions can reduce the ability to respond to natural disasters.
Difficulty with English	Language barriers make it more difficult to follow directions or interact with agencies before, during, or after a wildfire disaster. A person's ability to act during an emergency is compromised by language and cultural barriers.[16]
Older adults	Older populations are more likely to have pre-existing medical conditions or compromised mobility, which can reduce their ability to respond to wildfire. Older adults are more susceptible to air pollution and particulates associated with wildfire smoke. [17]
Children	Children's developing bodies make them particularly sensitive to health problems and environmental stresses.[18] Children have faster breathing rates, putting them at greater risk to respiratory problems from wildfire smoke. Because children don't have fully developed immune systems, they are more sensitive than adults to infectious diseases that can occur when water supplies are breached and sanitation systems are compromised after a disaster.[19]
Households without a car	During emergencies, people who do not have a car are less likely to evacuate or have access to emergency response centers.[20] Access to a car is also linked with higher wages and more financial stability.[21]
Non-white	Race is strongly correlated with disparities in health and vulnerability to natural hazards.[22] Minorities tend to be particularly vulnerable to disasters and extreme heat events, due in part to community isolation and cultural barriers.[23] Compared to other races, blacks have higher rates of heart disease and asthma, which can be compromised by wildfire smoke and environmental stress.[24]

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[a] Categories included here are from U.S. Census Bureau. See Appendix A for definitions and more information.

Austin's most vulnerable populations are largely concentrated on the east side, a result from early 20th-century segregation policy and the legacy of discriminatory practices. City policy in the 1930s required minorities to live in a specified district on the east side of what is today Interstate 35 if they wanted access public schools, utilities, and other city services. As in many other U.S. cities, inequitable housing practices and racial-restrictive covenants persisted beyond the policy, resulting in geographic isolation of minorities in east Austin.[25] Lack of geographic mobility translates into lack of economic mobility, especially for black Americans.[26] Today Austin has one of the nation's highest levels of income segregation; nearly all census tracts with above-median numbers of families in poverty are on the east side.[27]

Understanding the Trends

Today, Austin and several suburbs are among the nation's fastest-growing cities,[28] and most of Austin's growth is happening on the city's fringe. Growth trajectories over the next five years anticipate that this trend will continue.[29] The trends of population growth, vulnerable populations, and wildfire share the same spatial pattern. In other words, the fastest-growing parts of the city are those with highest wildfire threat and greater proportions of vulnerable people.

To reduce the susceptibility and increase the resiliency of Austin's residents to wildfire, it is important to understand the spatial patterns of wildfire threats and vulnerable populations. Where do wildfire potential and vulnerable people intersect? Where are overlapping vulnerabilities greatest? How can wildfire mitigation, response, and recovery be tailored to address a community's susceptibilities?

To help understand the spatial patterns of wildfire potential and vulnerable people, Headwaters Economics created the free, online, interactive Austin Wildfire & Vulnerable Populations Tool to help identify areas of overlapping threats and vulnerabilities. The tool uses data from the Austin and Travis County Community Wildfire Protection Plan (CWPP),[30] U.S. Census, and U.S. Centers for Disease Control and Prevention. Complete information about methods and data sources, as well as tips for using the tool can be found in Appendix A.

Information from the Austin Wildfire & Vulnerable Populations Tool can be used to identify census tracts where vulnerable populations and wildfire threats intersect, which can be used by land use planners, fire personnel, elected officials, community health organizations, disaster response organizations, and others for a variety of purposes, such as to:
- Prioritize and direct resources to neighborhoods where vulnerabilities may make it more difficult to prepare for, respond to, or recover from wildfire.
- Target education and outreach to those areas most at risk from wildfire and with the most at-risk people, based on different types of wildfire threats.
- Customize education and outreach materials in multiple languages for neighborhoods that have low English proficiency and are at risk to wildfire.
- Tailor wildfire response and operational plans for specific neighborhoods. For example, portions of the city with a higher proportion of disabled, elderly, or young residents may require different evacuation, emergency housing, and recovery plans. Preparations for language and cultural barriers can be made for neighborhoods with lower English proficiency.

Leaders in Austin can use the interactive tool to explore their own questions, but several key findings are summarized in the following chapter.

[1] City of Austin, TX, Office of Sustainability. Report on Climate Resilience. May 2014. http://austintexas.gov/sites/default/files/files/Toward_a_Climate_Resilient_Austin.pdf

[2] Travis County and City of Austin. 2014. Austin-Travis County Community Wildfire Protection Plan. http://www.austintexas.gov/wildfireprotectionplan

[3] https://widerimage.reuters.com/story/deadly-us-wildfires-leave-ranches-in-ruins

[4] http://www.kut.org/post/its-been-bad-year-texas-wildfires-it-will-probably-get-worse

[5] Abatzoglou, A. and Williams, A.P. 2016. Impact of anthropogenic climate change on wildfire across western US. *PNAS* 113(42): 11770-11775. http://www.pnas.org/content/113/42/11770.full

[6] Kitzberger, T., D.A. Falk, A.L. Westerling, T.W. Swetnam. 2017. Direct and indirect climate controls predict heterogeneous early-mid 21st century wildfire burned area across western and boreal North America. *PLoS ONE* 12(12): e0188486. https://doi.org/10.1371/journal.pone.0188486

[7] Radeloff, V.C., D.P. Helmers, H.A. Kramer, M.H. Mockrin, P.M. Alexandre, A. Bar-Massada, V. Butsic, T.J. Hawbaker, S. Martinuzi, A.D. Syphard, and S.I. Stewart. 2018. Rapid growth of the US wildland-urban interface raises wildfire risk. *PNAS*. http://www.pnas.org/lookup/suppl/doi:10.1073/pnas.1718850115/-/DCSupplemental

[8] Balch, J.K., B.A. Bradley, J.T. Abatzoglu, R.C. Nagy, E.J. Fusco, and A.L. Mahood. 2017. Human-started wildfires expand the fire niche across the United States. *PNAS* 114 (11): 2946-2951. http://www.pnas.org/content/early/2017/02/21/1617394114

[9] Collins, T.W. and B. Bolin. 2008. Situating hazard vulnerability: People's negotiations with wildfire environments in the U.S. Southwest. *Environmental Management* 44: 441-455.

[10] Turner, B.L., R.E. Kasperson, P.A. Matson, J.J. McCarthy, R.W. Corell, L. Christensen, N. Eckley, J.X. Kasperson, A. Luers, M.L. Martello, C. Polsky, A. Pulsipher, and A. Schiller. 2003. A framework for vulnerability analysis in sustainability science. *PNAS* 100(14): 8074-8079.

[11] County of Los Angeles Public Health. 2013. *Health Atlas for the City of Los Angeles*. Los Angeles, CA. http://healthyplan.la/wordpress/wp-content/uploads/2013/10/Health-Atlas-for-the-City-of-Los-Angeles-July-2013-FINAL-SMALL.pdf

[12] Fothergill, A. and L.A. Peek. 2004. Poverty and disasters in the United States: A review of recent sociological findings. *Natural Hazards* 32(1): 89-110.

[13] Wilkinson, R.G. and M.G. Marmot. 2003. Social determinants of health: The solid facts. World Health Organization. http://www.euro.who.int/__data/assets/pdf_file/0005/98438/e81384.pdf

[14] Fothergill, A. and L.A. Peek. 2004. Poverty and disasters in the United States: A review of recent sociological findings. *Natural Hazards* 32(1): 89-110.

[15] Balbus, J.M. and C. Malina. 2009. Identifying vulnerable subpopulations for climate change health effects in the United States. *Journal of Occupational and Environmental Medicine* 51(1): 33-37.

[16] Cooley, H., E. Moore, M. Heberger, and L. Allen. 2012. *Social Vulnerability to Climate Change in California*. California Energy Commission Pub. # CEC-500-2012-013.

[17] Balbus, J.M. and C. Malina. 2009. Identifying vulnerable subpopulations for climate change health effects in the United States. *Journal of Occupational and Environmental Medicine* 51(1): 33-37.

[18] County of Los Angeles Public Health. 2013. *Health Atlas for the City of Los Angeles*. Los Angeles, CA. http://healthyplan.la/wordpress/wp-content/uploads/2013/10/Health-Atlas-for-the-City-of-Los-Angeles-July-2013-FINAL-SMALL.pdf

[19] Balbus, J.M. and C. Malina. 2009. Identifying vulnerable subpopulations for climate change health effects in the United States. *Journal of Occupational and Environmental Medicine* 51(1): 33-37.

[20] Cooley, H., E. Moore, M. Heberger, and L. Allen. 2012. *Social Vulnerability to Climate Change in California*. California Energy Commission Pub. # CEC-500-2012-013.

[21] Raphael, S. and L. Rice. 2002. Car ownership, employment, and earnings. *Journal of Urban Economics* 52(1): 109-130.

[22] County of Los Angeles Public Health. 2013. *Health Atlas for the City of Los Angeles*. Los Angeles, CA. http://healthyplan.la/wordpress/wp-content/uploads/2013/10/Health-Atlas-for-the-City-of-Los-Angeles-July-2013-FINAL-SMALL.pdf

[23] Fothergill, A., E.G.M. Maestas, and J. DeRouen Darlington. 1999. Race, ethnicity and disasters in the United States: A review of the literature. *Disasters* 23(2): 156-173.

[24] Centers for Disease Control and Prevention. 2011. CDC Health Disparities and Inequalities Report—United States, 2011. *Morbidity and Mortality Weekly Report* 60 Suppl. (January 14, 2011). http://www.cdc.gov/mmwr/pdf/other/su6001.pdf

[25] Tretter, E.M. 2012. *Austin Restricted: Progressivism, Zoning, Private Racial Covenants, and the Making of a Segregated City*. Austin, TX: University of Texas, Institute for Urban Policy Research and Analysis. https://repositories.lib.utexas.edu/handle/2152/21232

[26] Chetty, R., N. Hendren, M.R. Jones, and S. Porter. 2018. Race and economic opportunity in the United States: an intergenerational perspective. The Equality of Opportunity Project. http://www.equality-of-opportunity.org/documents/

[27] Zehr, D. 2015. Austin's history of discrimination threatens its future. *Austin Statesman*, Jan. 18. http://projects.statesman.com/news/economic-mobility/wealth.html

[28] http://austin.culturemap.com/news/city-life/05-24-18-austin-suburbs-fastest-growing-cities-census-report/

[29] Central Health. 2017. Demographic Report. https://www.centralhealth.net/2017-demographic-report-final/

[30] Travis County and City of Austin. 2014. Austin-Travis County Community Wildfire Protection Plan. http://www.austintexas.gov/wildfireprotectionplan

II: KEY FINDINGS

When metrics about vulnerable populations are overlaid with information about Austin's wildfire potential, several key findings emerge:

- The fastest-growing parts of Austin are nearly all in areas of elevated or highest wildfire potential.
- Difficulty with English is prevalent on Austin's east side where wildfire potential is higher.
- Areas with highest wildfire potential and above-median numbers of families in poverty are nearly all on the east side.
- Tracts with above-median numbers of children and older adults have higher wildfire potential.
- A handful of neighborhoods exhibit overlapping vulnerabilities and elevated or highest wildfire potential, compounding the susceptibility to wildfire.

Many tracts with above-median proportions of vulnerable populations have higher wildfire threat than the greater Austin area as a whole (Figure 2.1).

Figure 2.1. Proportion of Census Tracts by Wildfire Potential Category with Above-Median Numbers of Vulnerable People. "All tracts" includes all of the greater Austin area.
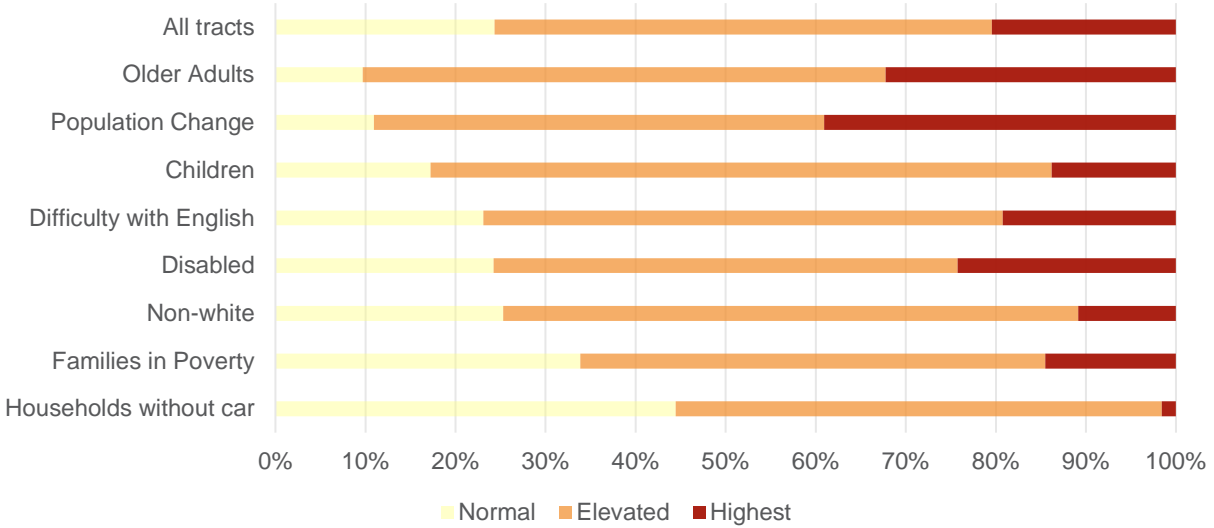
The fastest-growing parts of Austin nearly all have elevated or highest wildfire potential.
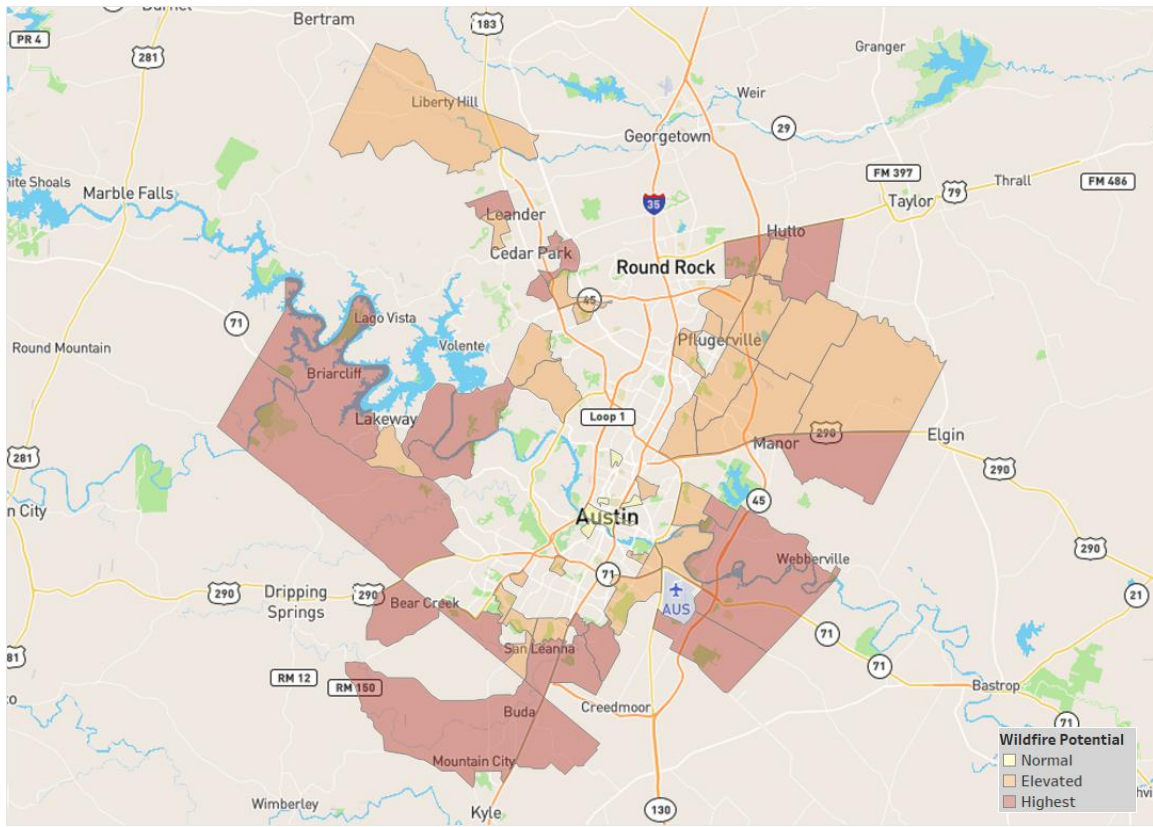

Figure 2.2. Tracts with Above-Median Population Growth Rates, 2012-2016.

The trend: Eighty-nine percent of Austin's fastest-growing tracts are in areas of elevated or highest wildfire potential, largely in a ring outlying the city center. Of the 64 census tracts with above-median population growth, 50 percent are in areas of elevated wildfire potential and 39 percent are in areas of highest wildfire potential.

What it means: As growth and density spread into outlying areas, more people are living in areas with heightened wildfire risk. It is likely that newcomers to these neighborhoods—whether moving outward from the city center or one of the 4,500 new arrivals moving to Austin each month—are likely unused to living with wildfire risk and not familiar with mitigation strategies and wildfire preparation practices. Since new growth and residential development are likely to be faster in these neighborhoods, opportunity exists to regulate new development to be more wildfire-resistant, taking into account wildfire vulnerabilities such as building construction and design, landscape requirements, access, and water supply.

Figure 2.3. Proportion of Tracts with Above-Median Population Growth Rates by Wildfire Potential.
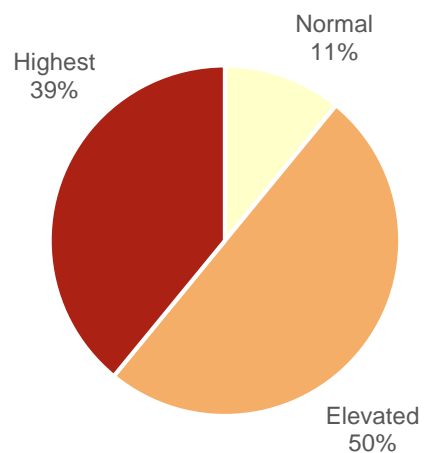
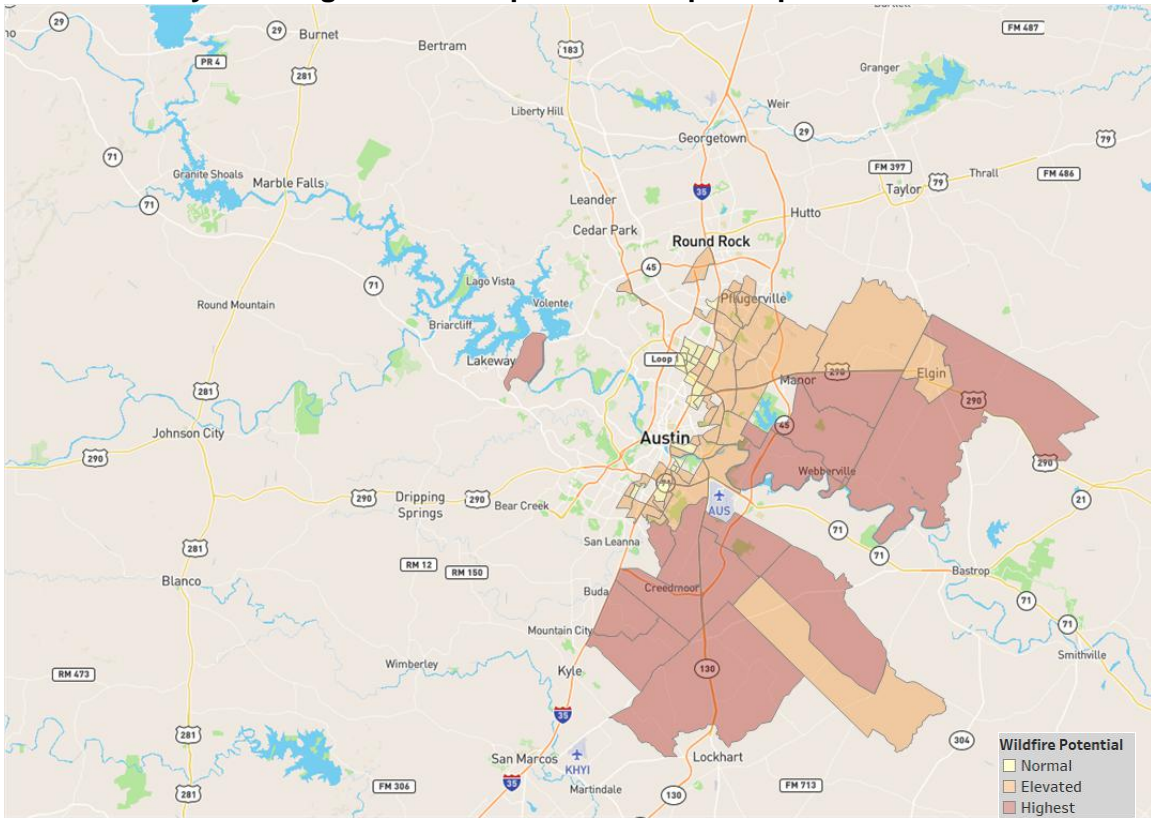**Difficulty with English is widespread in fire-prone parts of the east side.**

Figure 2.4. Tracts with Above-Median Difficulty Speaking English.

The trend: Austin residents with difficulty speaking English are nearly all on the east side, largely in areas where wildfire potential is elevated or highest. More than two-thirds of neighborhoods with above-median difficulty speaking English have elevated or highest wildfire potential.

What it means: Lack of proficiency with English can make it difficult to understand and follow directions. This may include mitigation instructions and preparedness educational materials, instructions and signage during evacuations or in emergency shelters, and post-event recovery resources such as aid forms. Language barriers are often accompanied by cultural barriers that can compound communication difficulties.

Figure 2.5. Proportion of tracts with Above-Median Difficulty Speaking English by Wildfire Potential.
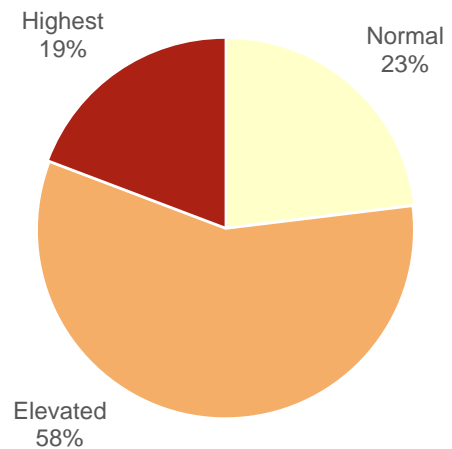
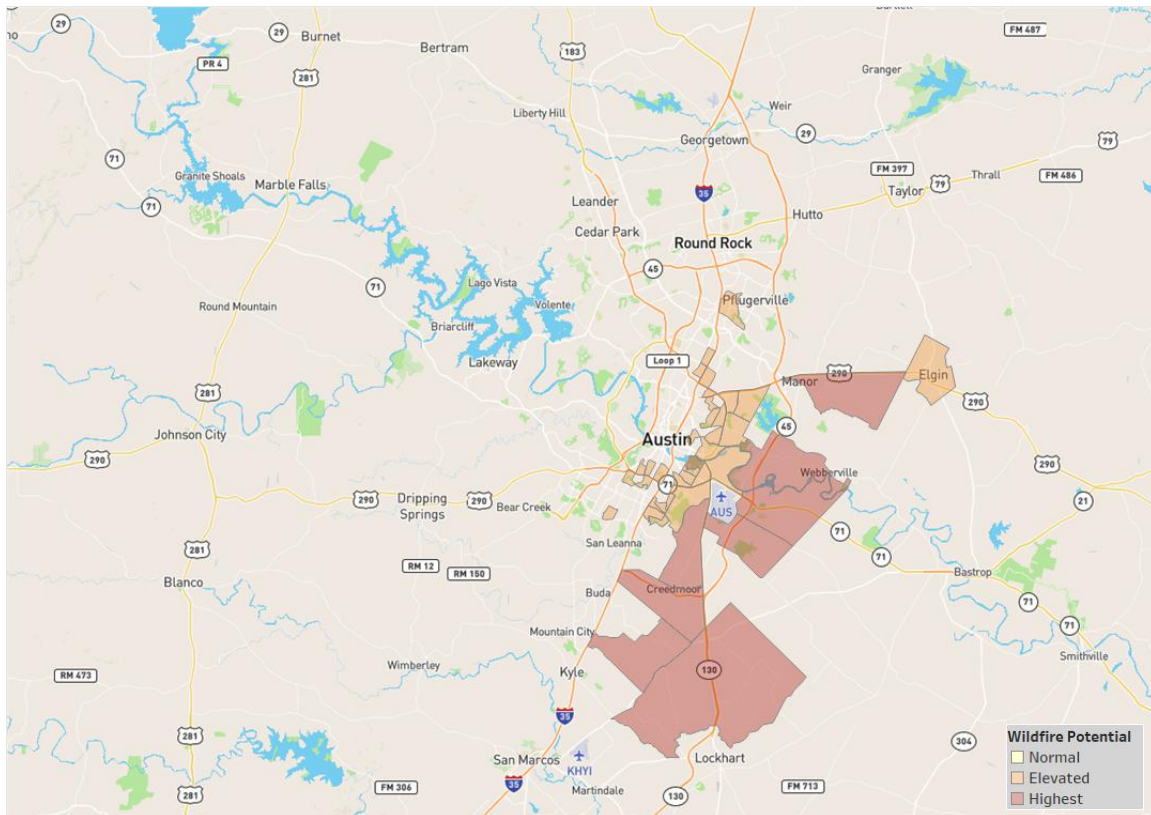**Poverty and wildfire threat intersect on the east side.**

Figure 2.6. Tracts with Above-Median Poverty and Elevated or Highest Wildfire Potential.

The trend: Although wildfire potential is distributed across the city, poverty is concentrated on the east side. Nearly all the 41 census tracts with both above-median numbers of families in poverty and highest or elevated wildfire potential are on the east side.

What it means: East-side families in poverty living in areas of wildfire potential may have fewer resources—including money and time—to devote to pre-disaster mitigation and maintenance on private property. It may not be possible to rely on voluntary initiatives or education campaigns, and activities such as retrofitting vulnerable components of a home to be wildfire-resistant or creating and maintaining defensible space may be out of reach for many residents. Shelter, transportation, and post-disaster aid are also more important in areas of higher poverty.

Areas with higher proportions of children and older adults have higher wildfire hazard.

The trend: Tracts with above-median numbers of children and older populations live with higher wildfire potential.

Of the 29 tracts with above-median numbers of children under the age of 5, 83 percent have elevated or highest wildfire potential, and are largely concentrated on the east side.

Of the 62 tracts with above-median proportion of adults over the age of 65, 90 percent have elevated or highest wildfire potential. Tracts are in both east and west Austin.

What it means: Children and the elderly are especially vulnerable to the health impacts of wildfire, including respiratory issues resulting from smoke and environmental stressors. Children and older populations are also more susceptible to post-disaster stressors and exposure to infectious diseases when water systems are compromised or in concentrated emergency housing. Mobility during evacuations and in post-event recovery can also be a challenge for these populations.
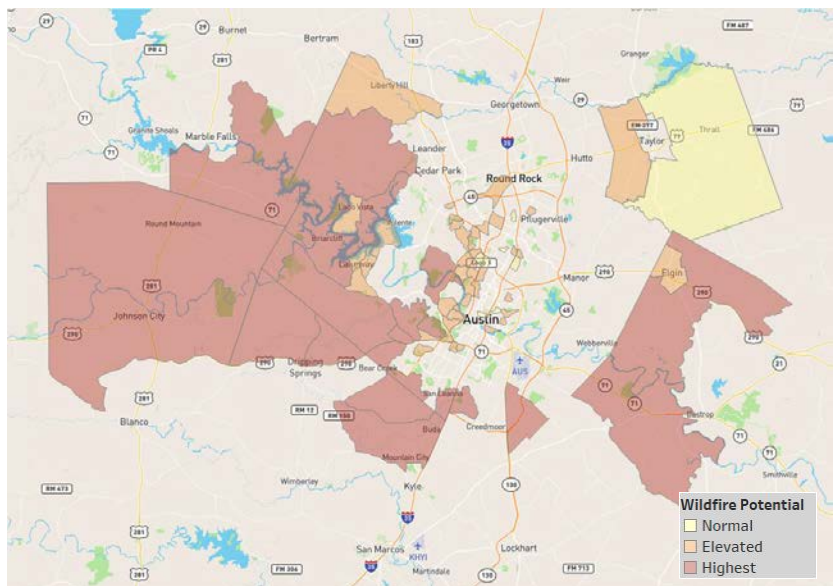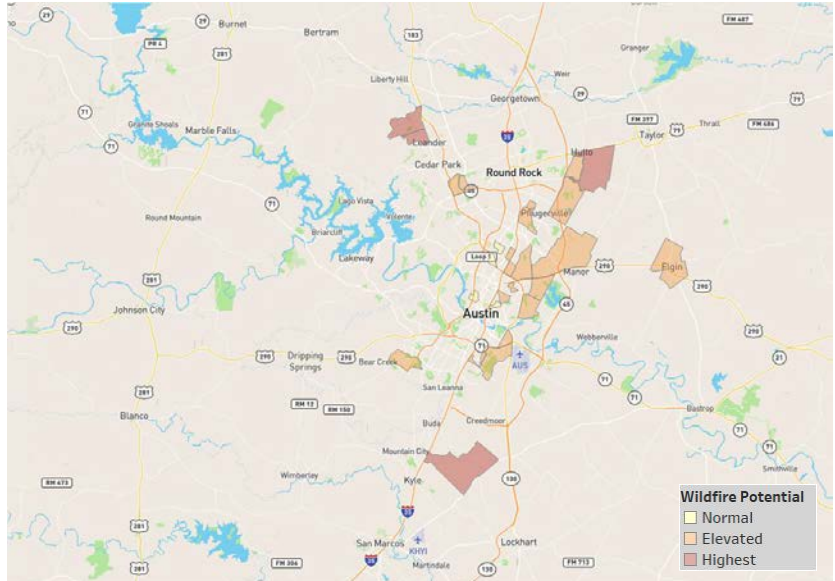

Figure 2.7. Top: tracts with above-median numbers of children under the age of 5. Bottom: Tracts with above-median numbers of adults over the age of 65.

Respiratory illness is higher in east side areas of wildfire hazard.

The trend: Areas with higher proportions of respiratory illness in adults, including asthma and chronic obstructive pulmonary disease (COPD), are generally concentrated on the east side, where wildfire potential is higher.

(Note that data are only available for census tracts within the incorporated City of Austin and are only available for adult populations. See Appendix A for details.)

What it means: Adults with asthma or COPD are especially vulnerable to wildfire smoke, which can cause coughing, chest pain, shortness of breath, and exhaustion. These health conditions can be further worsened by the stressors resulting from a disaster. Evacuation during a wildfire event may prove especially difficult, as acute respiratory issues can limit mobility. Availability of medical support and the need for medications or medical equipment may limit a person's desire or ability to leave home in an emergency or to be away from home for extended periods. The stresses of a disaster can have additional long-term health consequences for people suffering from respiratory illness.

During and after wildfires, additional medical resources, transportation support, medication, oxygen, and medical monitoring may be necessary.

These populations may also suffer negative effects from wildfire smoke originating from far away. Resources to communicate timely and accurate information about air quality and health care support may be helpful anytime the region is affected by wildfire smoke.
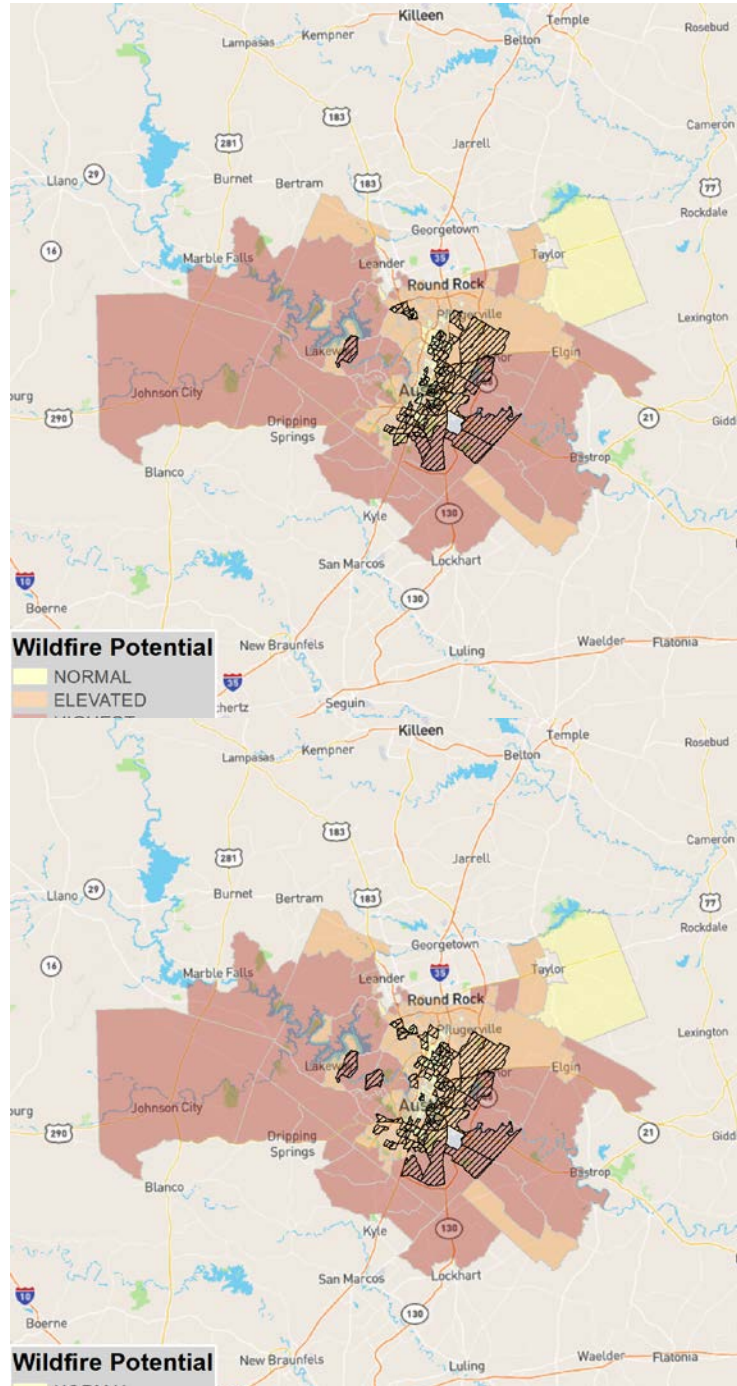

Figure 2.8. Top: Tracts with above-median numbers of adults with asthma. Bottom: Tracts with above-median numbers of adults with chronic obstructive pulmonary disease (COPD).

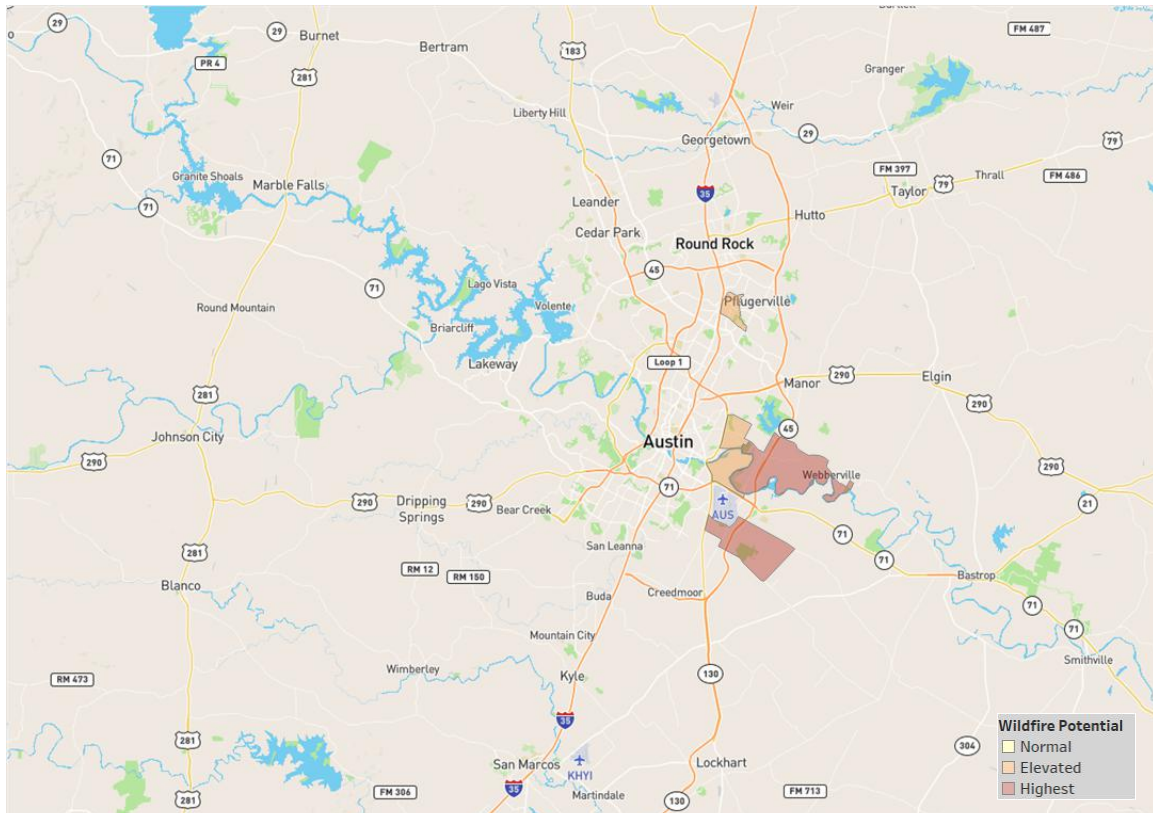**Six tracts stand out with multiple overlapping vulnerabilities.**

Figure 2.9. Of the six tracts with above-median population growth, families in poverty, difficulty speaking English, and non-white residents, half have elevated wildfire potential and half have highest wildfire potential.

The trend: Six tracts exhibit greater than median:
- population growth,
- families in poverty,
- difficulty speaking English, and
- non-white residents.

Four of these six also exhibit above-median adults with asthma and COPD.

Where these vulnerabilities intersect, there is also stronger wildfire potential. Three of the six tracts have elevated wildfire potential and three have highest wildfire potential. Five have surface fire potential, and one has crown fire potential. Two of the six also contain mobile home zoning.

What it means: Intersecting vulnerabilities increase susceptibility to wildfire, making it especially difficult to prepare for, respond to, and recover from a disaster. Additional resources may need to be directed here before, during, and after wildfire events.

III: STRATEGIES & SOLUTIONS

Using detailed information about where vulnerable people and wildfire potential intersect, Austin can tailor its wildfire preparation, response, and recovery programs to reduce risk and address specific susceptibilities. Several potential strategies are outlined here.

Apply land use planning tools in fast-growing areas with higher wildfire potential.
Since most of the fastest-growing parts of Austin are in areas of elevated or highest wildfire potential, there is an opportunity to require that new development meet wildfire-resistant standards. Regulatory tools can also help direct development away from the most hazardous areas. Specific tools and strategies were outlined in recommendations provided by the Community Planning Assistance for Wildfire (CPAW) program in 2016,[1] including:

- *Adopt a wildland-urban interface code* (such as the International Code Council's WUI Code). Many communities use WUI codes to require that new developments use fire-resistant building materials and design, have adequate road systems and water supply, and use landscaping that will reduce wildfire risk.

- *Revise land development regulations to address wildfire*. Priorities include incorporating wildfire risk and mitigation early in the development review process, integrating wildfire risk reduction into zoning, incorporating vegetation management into the land development code, and incorporating wildfire hazard criteria in subdivision approval.

- *Update the zoning map to direct growth toward safe areas*. Based on data about wildfire risk, rezoning can help direct growth toward areas with reduced risk and away from areas with higher risk.

Specific information and implementation guidance for each of these strategies are provided in the CPAW recommendations.

Prioritize resources for more vulnerable neighborhoods.
City mitigation resources would be wisely invested in east-side neighborhoods where intersecting vulnerabilities make mitigation, risk-reduction, and pre-disaster preparation difficult. Relying on voluntary programs like Firewise Communities may not be sufficient. Instead, regulatory measures and assistance programs such as vegetation management may be necessary. Additional emergency planning for evacuation, temporary housing, and recovery aid may be necessary for more vulnerable neighborhoods.

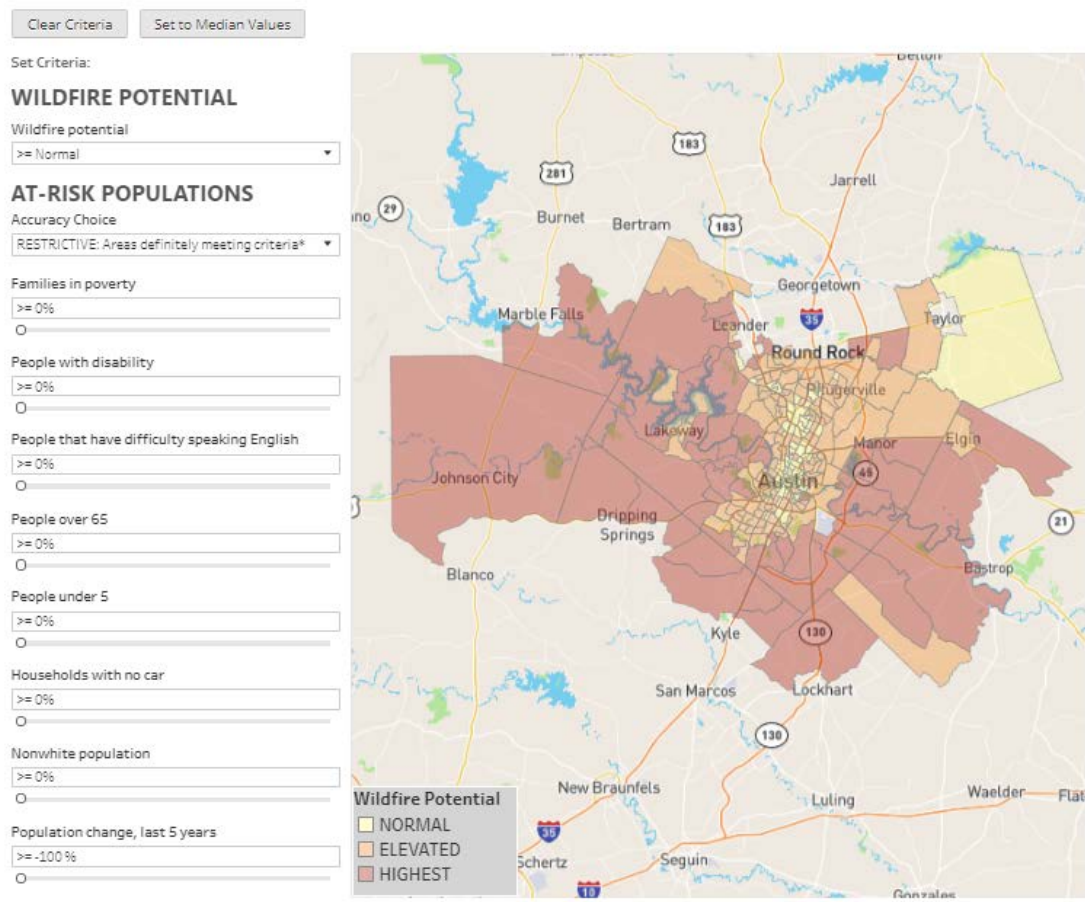**Target and customize education and outreach.**
Education and outreach about wildfire hazard, property owner responsibilities, and response actions are more effective if the message and messenger are tailored to the specific audience to help overcome barriers. Many of Austin's new residents may be unaccustomed to living with wildfire risk, and residents moving from the city center outward may be unaware of the increased wildfire threat on the city fringe. Outreach can be leveraged through existing programs and services that newcomers may access, such as utility services, vehicle licensing, tax notices, and school enrollment. Outreach materials and emergency planning in multiple languages can be prioritized for Austin's east side, which has high proportions of people with difficulty speaking English.

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[1] Community Planning Assistance for Wildfire. 2016. Recommendations for Austin, Texas. Available at: https://planningforwildfire.org/wp-content/uploads/2017/03/CPAW-Austin-Recommendations_Final.pdf

APPENDIX A: DATA SOURCES, METHODS, & USER GUIDE

The Austin Wildfire & Vulnerable Populations Tool is designed to help city officials, fire personnel, residents, and land managers understand where the highest risk of wildfire overlaps with populations that may have social, economic, and health disadvantages in order to more effectively and efficiently reduce risk. Understanding where populations are most vulnerable can help Austin prioritize resources before, during, and after wildfires. For example, the tool can help:

- Prioritize and direct resources to neighborhoods where vulnerabilities may make it more difficult to prepare for, respond to, or recover from wildfire.

- Target education and outreach for those areas most at risk from wildfire and with the most at-risk people, based on different demographics and wildfire threats.

- Customize education and outreach materials in multiple languages for neighborhoods that have low English proficiency and are at-risk to wildfire.

- Tailor wildfire response and operational plans for specific neighborhoods. For example, portions of the city with a higher proportion of disabled, elderly, or young residents may require different evacuation, emergency housing, and recovery plans.

The Austin Wildfire and Vulnerable Populations tool can be found at
https://headwaterseconomics.org/wildfire/homes-risk/austin-wildfire-population-risk.

Data Sources & Methods

The tool includes nine selection criteria and six additional variables in the mouse-over pop-up box. The definitions of each variable are summarized in Table A.1. The data are at the census tract level and derived from three main sources.

Census Tracts

The tool maps and summarizes data at the census tract level, as delineated by the U.S. Census Bureau. Census tracts are delineated by population rather than area, so their size varies widely depending on population density. Tracts generally have population ranging from 1,200 to 8,000 people, with an average of 4,000.

Use of U.S. Census data has limitations. Census categories provide a static snapshot of inherently dynamic, shifting processes such as age, constructs of race, and economic mobility.[1] The artificial delineation of census tracts is generally not aligned with wildfire behavior or other natural processes. Census tracts are not always meaningful delineations and do not typically align with other known geographies such as neighborhoods or zip codes. To facilitate better cross-referencing with known landmarks, the tool provides a neighborhood description and lists the census tract number and county.

Wildfire Potential

Wildfire potential data were provided by the Austin Fire Department Wildfire Division and are based on wildland fuels data and fire behavior modeling conducted during the formation of the 2014 Austin and Travis County Community Wildfire Protection Plan (CWPP).[2] The data were developed using the FlamMap fire behavior simulation model,[3] which incorporates biophysical characteristics such as slope, topography, and vegetation with information about historic ignition patterns and the risk associated with ignition of structures under worst-case weather scenarios.

Wildfire potential was summarized to the census tract to align with the At-Risk Population variables. Wildfire potential is broken into three classes: Normal, Elevated, and Highest, as defined by flame length (measured in feet) and rate of spread (measured in miles per hour) (Table A.1). Information is also provided in the pop-up box for each tract about the average flame length or average rate of spread based on the simulation modeling. Static maps showing flame length and rate of spread with census tracts are also available for download.[4]

Table A. 1: Wildfire Potential Classes			
Criteria	**Normal Wildfire Potential**	**Elevated Wildfire Potential**	**Highest Wildfire Potential**
Average flame length (feet)	1.7	5.4	10.5
Average rate of spread (miles per hour)	0.11	0.42	0.75

Some tracts also show "surface fire potential" or "crown fire potential" based on the average characteristics. Where noted, "surface fire potential" indicates the likelihood that if a fire is ignited, it will burn along the ground through a horizontally continuous and unbroken layer of fuels. Surface fire potential is derived from higher rate of spread. Where noted, "crown fire potential" indicates the likelihood that if a fire is ignited, it will become a wind-driven fire that travels from treetop (crown) to treetop in dense stands of trees. Crown fire potential is derived from higher potential flame lengths.

At-Risk Populations & Population
Variables under the categories *At-Risk Populations* and *Population* are from the U.S. Census Bureau's latest release of the American Community Survey (ACS) five-year estimates, which represent the socioeconomic conditions during a five-year rolling survey period.[5] Data are from the 2012 to 2016 period. ACS data are from a survey, so the results fall within a range of possible values, as shown in the pop-up box. The tool addresses the range of possible values through the drop-down called "accuracy choice," further described below.

Health
Wildfire-related health variables are from the Centers for Disease Control and Prevention 500 Cities Project.[6] Health variables are derived from a multi-level statistical modeling framework using data from CDC Behavioral Risk Factor Surveillance System, the Census 2010 population, and the American Community Survey estimates. Data are only available for census tracts within the incorporated City of Austin and are only available for adult populations. Adults with asthma and adults with chronic obstructive pulmonary disease (COPD) are shown, as those conditions can be worsened with the presence of smoke. The stressors resulting from wildfire can exacerbate many other chronic health conditions.

Table A.2: Tool Variables & Definitions		
Variable		**Definition**
Wildfire Potential[A]	Wildfire Potential	Derived from wildfire risk modeling and grouped into three classes: normal, elevated, or highest.
	Average rate of spread	Mean rate of expected wildfire spread in miles per hour. Faster rates of spread are generally associated with surface fires in grass and brush.
	Average flame length	Average expected wildfire flame length in feet. Longer flame lengths are generally associated with crown fires in trees.
	Crown Fire Potential	This feature will be noted for tracts where there is a high likelihood that a fire will burn into the canopy of elevated fuels (i.e., trees). Crown fires tend to burn with greater intensity, have longer flame lengths, cause greater ember cast, and burn more slowly than surface fires.
	Surface Fire Potential	This feature will be noted for tracts where there is a high likelihood that a fire will burn in the surface fuel layer, such as in downed needles, leaves, grass, dead and down branches, and low brush or short trees. Surface fires tend to burn with less intensity and shorter flame lengths, but with fast rates of spread.
At-Risk Populations[B]	Families in Poverty	Percentage of families in the census tract living below the poverty line. The Census defines a family as a group of two or more people who reside together and are related by birth, marriage, or adoption. The Census uses a set of income thresholds that vary by family size and composition to define who is poor.
	People with Disability	Percentage of people in the tract estimated to have a disability, based on self-reporting questions in the American Community Survey.
	Difficulty speaking English	Percentage of people in the tract estimated to have difficulty speaking English based on self-reporting questions in the American Community Survey.
	People over 65	Percentage of people in the tract over the age of 65.
	People under 5	Percentage of people in the tract under the age of 5.
	Households with no car	Percentage of households without a car.
	Non-white population	Percentage of people who self-identify as Black or African American, American Indian or Alaska Native, Asian, Native Hawaiian or other Pacific Islander, or Some Other Race. Respondents may report more than one race. (Note that ethnicity, including Hispanic is not included in this category. A person can be any combination of race and ethnicity.)
Population[B]	Change in last 5 years	Percentage change in population during the five-year American Community Survey reporting period from 2012-2016.
	Current Population	Estimated number of residents as of 2016, the end of the American Community Survey five-year reporting period.
	Housing Units	Estimated number of total occupied housing units as of 2016, the end of the American Community Survey five-year reporting period.
Health[C]	Adults with Asthma	Current asthma prevalence among adults aged $\geq$18 years.
	Adults with COPD	Chronic obstructive pulmonary disease among adults aged $\geq$18 years.

A. Source: Austin Fire Department Wildfire Division.
B. Source: U.S. Census Bureau, 2016. American Community Survey. Data are from the latest release of the American Community Survey (ACS) five-year estimates, which represent the socioeconomic conditions during a five-year rolling survey period. Data are from the 2012 to 2016 period.
C. Source: U.S. Centers for Disease Control and Prevention, 2017. 500 Cities Project. Data are only available for census tracts within the incorporated City of Austin and are only available for adult populations.

Tips for Using the Tool

Change Criteria
The map display will automatically refresh as you change criteria under "Wildfire Potential" and "At-Risk Populations." The default criteria for the map is to have all criteria at their lowest possible value. As you change criteria, the number of selected census tracts will be displayed in the lower left corner.

Map Interactions
The map is interactive. You can zoom and pan using your mouse. As you hover your mouse on the map, a pop-up box with more information about the underlying census tract will appear. If you click on a tract, it will be highlighted on the map until you click elsewhere. You can return to the full extent view by clicking the small home button in the upper left corner. You can also search for specific places by typing in the search box in the upper left corner.


Click the home button to return to the full extent of the map after zooming. Search for specific locations by typing in the search window.
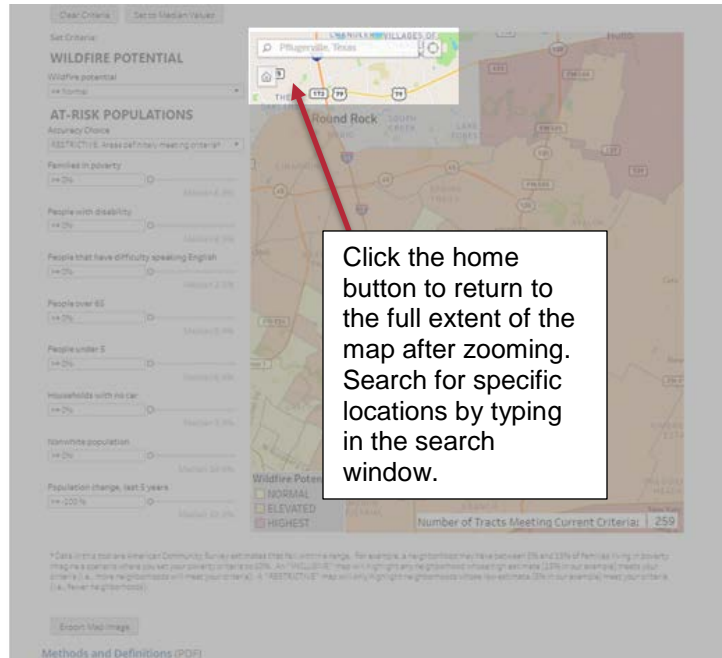
Clear Criteria
Click on the "Clear Criteria" button to reset all criteria to their lowest possible value. This is the default setting when you first open the tool.

Set to Median
Click the "Set to Median" button to put all values at the median for the entire greater Austin area. When the "Set to Median" button is selected, the map is automatically changed to the "Inclusive" setting (see more below).

Clear criteria to zero or set all values to the Austin median.
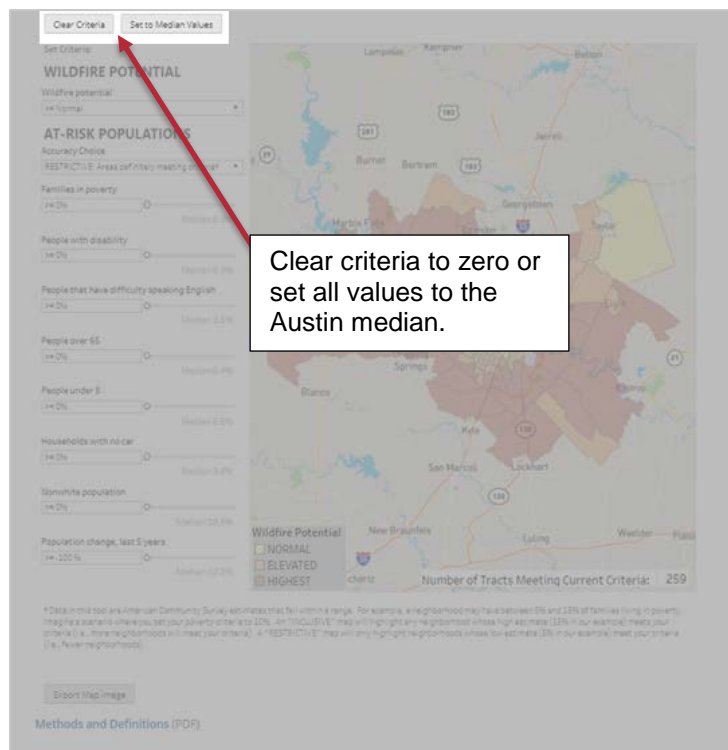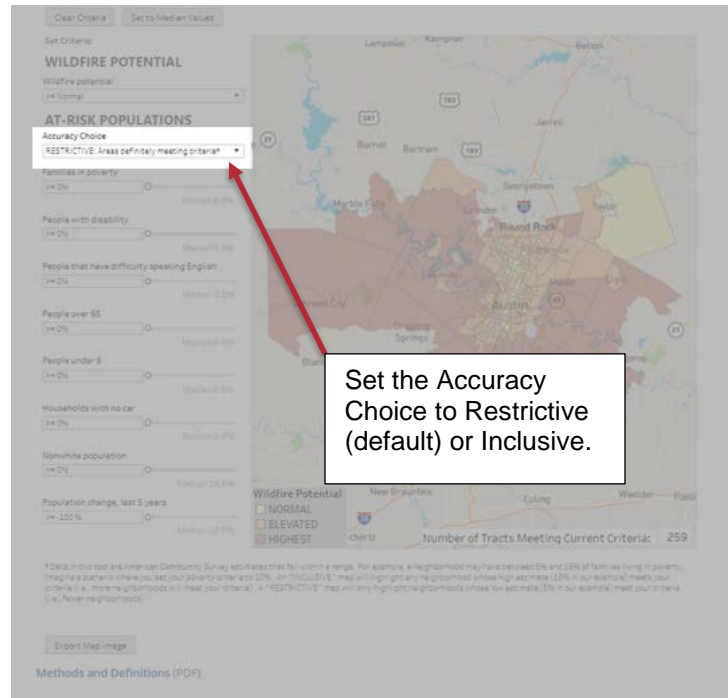
Accuracy Choice:
Restrictive versus Inclusive

Since the variables described under the categories *Populations-At-Risk* and *Population* are derived from a survey (ACS), the results fall within a range of possible values. For example, a tract may have between 5 percent and 15 percent of families living in poverty. The "At-Risk Populations" criteria will act on either the lower or upper estimate, depending upon whether you select a "Restrictive" or "Inclusive" map. The map defaults to the "Restrictive" category.

To understand how this works, visualize a neighborhood where the estimated share of families in poverty, based on the ACS survey results, is 5-15 percent (Tract A), and another neighborhood where the share is 12-20 percent (Tract B). What will happen if you set the poverty criteria to greater than or equal to 12 percent? (See figure below.)

Set the Accuracy Choice to Restrictive (default) or Inclusive.

A "restrictive" map will not include Tract A, since you cannot say with certainty that more than 12 percent of the families live in poverty (the true value may be as low as 5 percent). Tract B would be selected, since its entire range is greater than 12 percent.

An "inclusive" map would include both Tract B and Tract A, since it is possible that more than 12 percent of families live in poverty in Neighborhood A (the true value may be as high as 15 percent).
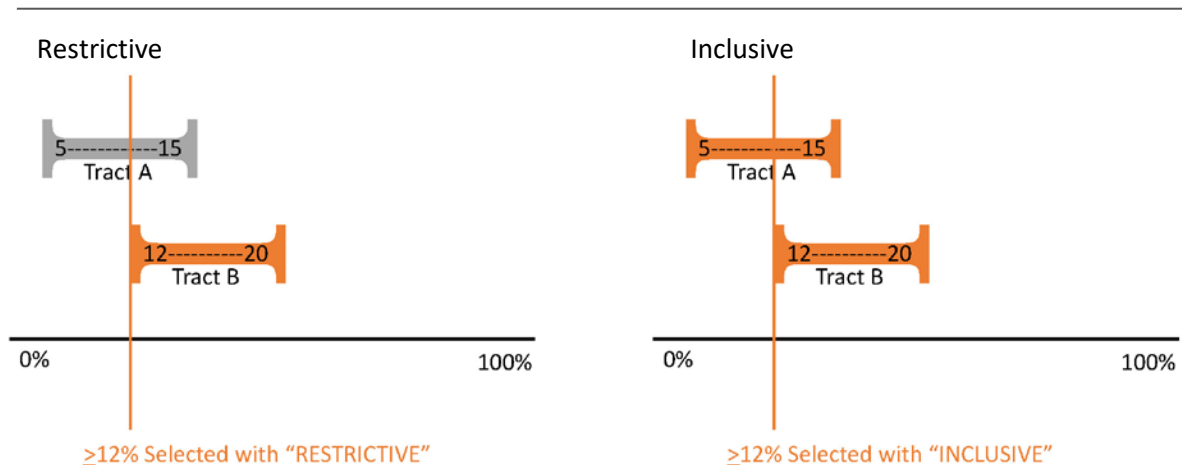
Restrictive versus Inclusive Accuracy Choice. A "Restrictive" map will show all tracts that *definitely* meet the criteria. An "Inclusive" map will show all tracts that *may* meet the criteria.

Populations at Risk Report
If you click on a tract, you have the option to run a Populations at Risk (PAR) report for that census tract. The PAR report will be generated in Excel and downloaded to your computer automatically. The report provides detailed socioeconomic information about vulnerable populations in your selected census tract. You can also visit the [Populations At Risk](#) tool[7] to generate free, custom reports for any location in the United States, including multiple census tracts, cities, and counties.

From the pop-up box that appears when you click a tract, select "Generate and Download "Populations At Risk" Report.
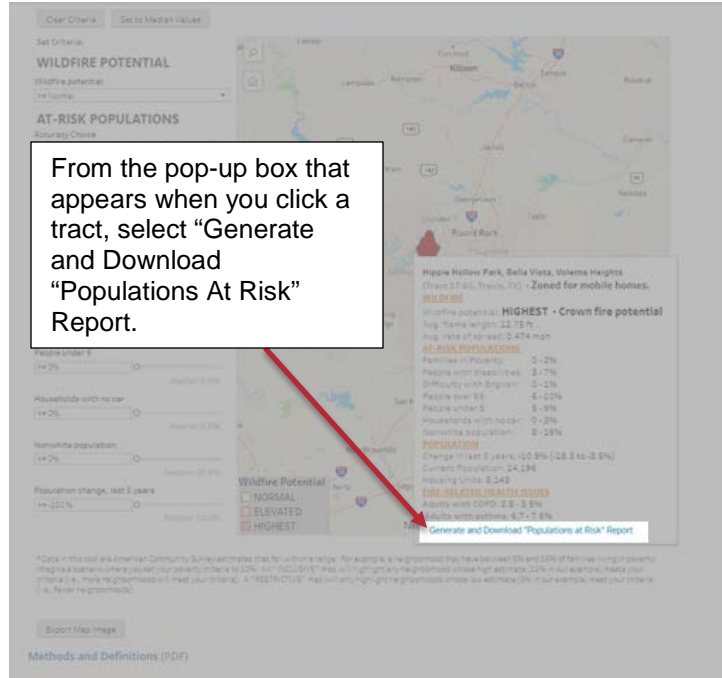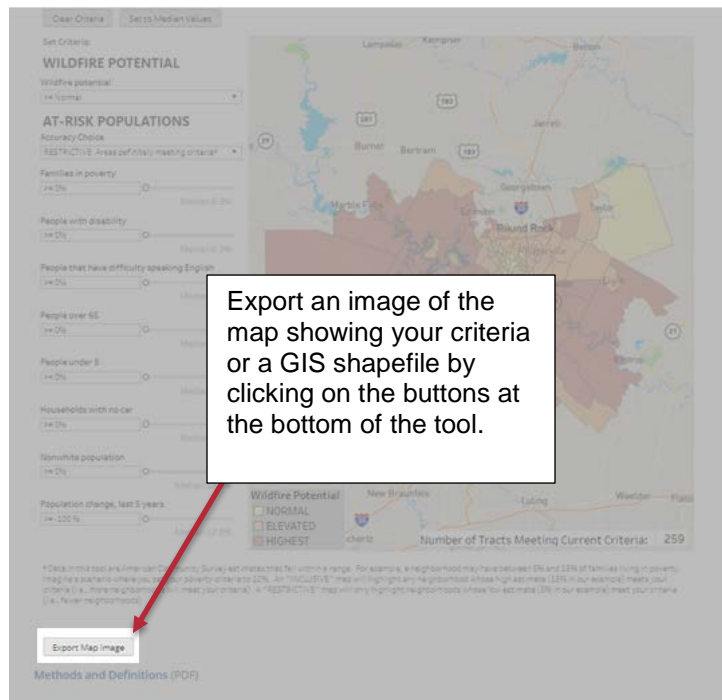
Downloading and Exporting from the Tool
The map tool allows users to export data and images in several formats.

Export Map Image. To export the map as a PNG (image), click on the "Export Map Image" button below the map. The image will download to your computer and a pop-up box will alert you when the download is complete. The export will include the map with selected tracts and a list of the criteria selected.

GIS Shapefile. To download a GIS shapefile of the data, click on "Download data as a GIS Shapefile" underneath the map. The shapefile will contain attributes of all wildfire exposure criteria and at-risk populations criteria for each census tract displayed in the interactive tool.

Export an image of the map showing your criteria or a GIS shapefile by clicking on the buttons at the bottom of the tool.

[1] Bolin, B. and L.C. Kurtz. 2018. Race, Class, Ethnicity, and Disaster Vulnerability. In: H. Rodríguez et al. (eds.), *Handbook of Disaster Research*. Switzerland: Springer Nature. https://doi.org/10.1007/978-3-319-63254-4_10

[2] Travis County and City of Austin. 2014. Austin-Travis County Community Wildfire Protection Plan. http://www.austintexas.gov/wildfireprotectionplan

[3] Finney, M.A. 2006. An overview of FlamMap fire modeling capabilities. Pp. 213-220 in Fuels management—how to measure success: conference proceedings. Pub. RMRS-P-41. Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station.

[4] Map of Flame Length and Census Tracts can be downloaded at https://headwaterseconomics.org/wildfire/homes-risk/austin-wildfire-population-risk-mapA.pdf. Map of Rate of Spread and Census Tracts can be downloaded at https://headwaterseconomics.org/wildfire/homes-risk/austin-wildfire-population-risk-mapB.pdf.

[5] U.S. Department of Commerce. 2017. Census Bureau, American Community Survey Office, Washington, D.C.

[6] Centers for Disease Control and Prevention 500 Cities Project. https://www.cdc.gov/500cities/index.htm

[7] Headwaters Economics. Populations At Risk Tool. Available at https://headwaterseconomics.org/tools/populations-at-risk/