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WILDFIRE FUEL MANAGEMENT AND RISK MITIGATION

WHERE TO START?

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Ellie Arrowsmith, Frederick Dube Fortier, Anne D. Cope, et al.



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INTRODUCTION

As the cost of wildfires continues to accumulate, policymakers, homeowners, and community leaders have spearheaded multiple new initiatives to contain the impact of forest fires. From the 20+ bills passed in California in 2019 promoting wildfire mitigation efforts including home hardening initiatives, to the desire to establish property hardening standards for insurance, policymakers across the nation are working tirelessly to reduce the impact of wildfires on their community.

Homeowners in areas of high wildfire risk are experiencing more than just the direct effects of home loss or displacement costs incurred because of wildfire; they are also suffering from an insurance crisis. Properties in rural and suburban areas deemed high-risk are seeing their insurance coverage decrease and their premiums increase. While regulators work on policy, both insurers and homeowners are looking for opportunities for wildfire risk mitigation on a property-level, to understand what they can do to increase their home's safety today.

[The Insurance Institute for Business & Home Safety](#) (IBHS) are experts in resiliency research, including home hardening and wildfire risk factors, and have published comprehensive [Suburban Wildfire Adaptation Roadmaps](#), offering homeowners advice on effective wildfire mitigation for their property. These findings rely on extensive research, collaboration with field experts, and lab experiments offering scientific proof that homeowners can decrease the risk of damage from wildfires. They allow us to understand what risk factors promote the spread of wildfire from fuel sources to homes and how home maintenance can defend against the threat of ignition from embers, radiation, and flame.

[Zesty.ai](#), an AI-based property risk analytics company, has partnered with IBHS to supplement these laboratory findings with lessons learned from analyzing the damages caused to properties in historical fires. Zesty.ai is uniquely equipped to shed light on this, with its proprietary wildfire property loss database developed for Z-FIRE™, which offers predictive wildfire risk scores powered by Artificial Intelligence (AI). The property loss database was consolidated by analyzing over 115,000+ properties across 1200+ historical fire events in North America. This enhanced understanding of historic wildfires can provide crucial pointers to property owners looking for advice on protecting their property from potential wildfires. The Z-FIRE™ model is the first AI model and second wildfire risk model to be approved by the California Department of Insurance (CDI) in connection with a rate filing.

IBHS has found that minimizing combustible fuel around a property is critical in improving property resiliency to wildfire risk. In this study, IBHS and Zesty.ai performed an analysis of the relationship between the presence of fuels (vegetation and structures) surrounding a target structure and the destruction rate observed in historical wildfire events.

The conclusions are clear: Mitigation efforts to reduce fuel around a property can double its likelihood of surviving a wildfire event, and both property-level and community-level mitigation efforts should be part of a comprehensive roadmap to protecting homes. So, where to start?

1. Starting from the outside wall, remove brush, shrubs, and other small trees to prevent flames from reaching your home. Cut down overhanging branches so that no burning material can fall on your roof.
2. If multiple structures surround your home, make sure they are clear of vegetation fuel so that those structures don't catch fire and pass the flame to your home. If not in use, remove decks, sheds, and other buildings which can fuel a fire.
3. Spearhead or join community initiatives to reduce wildfire fuel in the neighborhood to protect both your community and your home.

For individuals and community leaders ready to begin or intensify community-wide initiatives, there are local, state-wide, and national resources available that specialize in connecting, organizing, and educating communities ready to begin mitigation efforts. These programs are aimed at bridging efforts between homeowners, business owners and governmental agencies to prepare and protect their communities from wildfires. Most community-level programs promote community-wide fuel management, which is shown to materially reduce risk for each homeowner.

While this study focuses on the individual impact that homeowners can have on their homes, there are substantial state-wide benefits to fuel management. In "[Finding the Sweet Spot in Wildfire Mitigation](#)" presented at the 2020 Property Insurance Report National Conference, Zesty.ai determined that California could avoid up to one quarter (26%) of all the economic losses from wildfire if all homeowners in wildfire-prone areas were to clear the vegetation up to just 30ft around their homes, and nearly half (45%) of the average economic losses if homeowners cleared the vegetation up to 100ft around their homes.

METHODOLOGY

While Zesty.ai has access to more than 20 years of historical losses, this study focused on the 71,000+ properties involved in a wildfire between 2016-2019. To assess the relationship between vegetation, buildings, and property vulnerability, Zesty.ai analyzed high resolution satellite and aerial imagery of more than 71,000 properties that fell within one of 415 wildfire perimeters over the three-year period. Zesty.ai leveraged computer vision technology powered by artificial intelligence to evaluate aerial and satellite imagery of each property prior to the corresponding wildfire event to get a snapshot of the property's attributes before it was affected by fire. Imagery taken of each property after the corresponding wildfire was assessed to determine whether or not the property survived.

From IBHS's extensive research, we know that combustible fuel and its proximity play a critical role in determining a property's vulnerability to damage from wildfires. These combustible fuels are often greatest in the form of buildings and vegetation, which were the focus of this study.

IBHS has identified three main 'zones' of defensible space, each of which has a relationship with the vulnerability of a property in the event of a wildfire: 0-5 feet from the property, 5-30 feet from the property, and 30-100 feet from the property. While vegetation overhanging the roof of a structure would otherwise be included in the IBHS 0-5 ft zone of interest, this study split vegetation overhanging the roof and vegetation in the 0-5 ft buffer from the building into two separate zones to identify if there was a material risk difference.

For each of the 71,000 properties involved in wildfires, Zesty.ai used pre-wildfire imagery and computed the:

- **Areas of interest (Defensible Zones):** overhanging the property, 5 ft around the property, 30 ft around the property, and 100 ft around the property
- **Vegetation coverage per area of interest:** percentage of the zone covered by vegetation
- **Presence of building:** Part or all of one or more structures overlapping with the zone of interest.

This was done by leveraging Convolutional Neural Networks (a type of Artificial Intelligence algorithm) that can process imagery automatically to determine which pixels in an image correspond to vegetation and which pixels correspond to building structures. Through this method, Zesty.ai computed what fraction of the area in a given zone was occupied by combustible vegetation and if a building was present in the zone, as demonstrated in **Figure 1**.



Figure 1. Visual example of (1) buildings and vegetation detected and (2) a 0-5 ft zone, 5-30 ft zone, and 30-100ft zone around the home

For the same 71,000 properties, Zesty.ai used post-wildfire event imagery and determined which properties survived the affecting fire and which ones were destroyed. **Destruction rate** — or the fraction of homes destroyed when involved in a wildfire in the past -- is key to determining which mitigation actions are important.

The first analysis presented in this study focuses on the impact of heavy vegetation on the destruction rate of wildfire.

For the purpose of comparison, a zone is deemed to have “heavy vegetation” if vegetation covers more than 50%+ of the zone (i.e., half of the area is covered by leaves, branches, or other vegetation). It is not the purpose of this analysis to identify the lowest level of vegetation tolerable for wildfire risk, but rather show that the relationship between vegetation and wildfire risk is a gradient (see **Table 2**); reducing vegetation demonstrably reduces the risk of destruction. More than 1 out of every 3 homes involved in wildfires in 2016-2019 had “heavy vegetation” in at least one of their surrounding zones. As the data will show, the destruction rates of those highly-vegetated homes are materially higher. However, risk is present even at the lowest level of vegetation; when combined with other factors like wind and slope a small fire can spread rapidly.

Wildfires are complex phenomena driven by multiple risk factors and how they interact with each other. In other words, a risk factor might only increase the risk of destruction if other risk factors are also present. For example, having branches over your home may be problematic if the home is in proximity to a large source of fuel and therefore likely to spread fire to the branches. With this complexity in mind, the second analysis looks at the risk of having a building in a given zone, given that the building is surrounded by medium-to-high vegetation in the neighborhood (About one-third (30%) or more of the neighborhood zone is covered in vegetation).

DETAILED RESULTS

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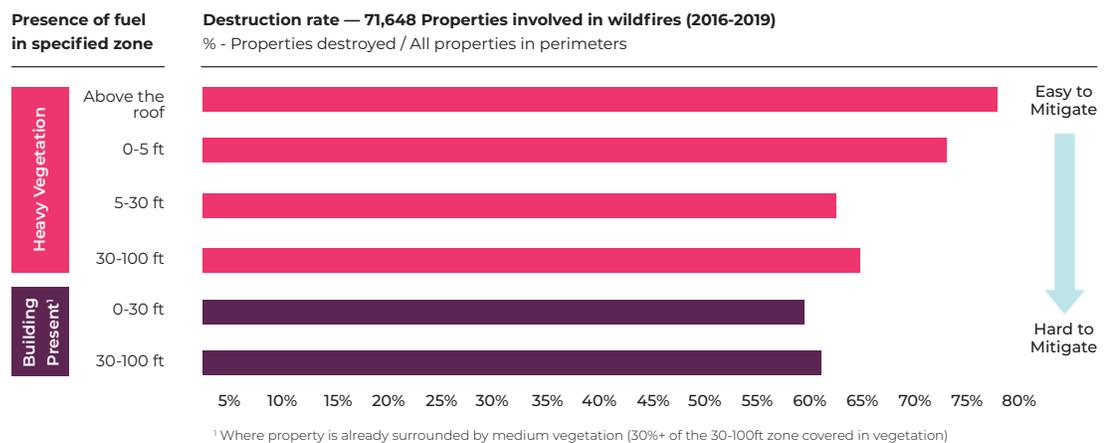


Figure 2. Structure destruction rate for properties with high surrounding fuel sources

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Understanding which homes survived and which homes were surrounded by fuel (vegetation or buildings) allows us to quantify the importance of mitigation efforts. **Figure 2** presents the relative risk associated with the presence of fuel in the four specified defensible zones surrounding a home. This analysis shows that the fuel and zones that are the easiest to access and mitigate (vegetation immediately around the property) coincide with the highest level of destruction. Because of this, homeowners can feasibly make a large impact on defending their home by starting mitigation efforts close to their main building and working outwards, all the way up to community-wide initiatives. Limiting the spread of flames is the number one priority.

VEGETATION

As shown in **Figure 2**, and unsurprisingly, the presence of vegetation around a home increases its chances of being destroyed. To quantify the effect that leaves, bushes and shrubs can have on a home's risk, Zesty.ai compared the historical destruction rates of properties with heavy and light vegetation. The results show that by reducing surrounding vegetation, homeowners can keep the flames at bay.

Zone	Destruction rate Heavy vegetation	Destruction rate Light-Medium vegetation	Difference in likelihood of destruction
Area based on the rooftop outline	More than 50% of the zone is covered by vegetation	Less than 50% of the zone is covered by vegetation	Heavy compared to Light Vegetation
Over the roof	77.8%	41.3%	1.9x
0-5 ft from the structure	72.7%	39.4%	1.9x
5-30 ft from the structure	62.0%	35.1%	1.8x
30-100 ft from the structure	64.5%	34.1%	1.9x

Table 1. Risk Reduction between buildings with more than 50% vegetation density in the specified zone, and buildings with more than 50% clear area in the specified zone

Table 1 shows that mitigation efforts in all zones can have a significant impact on a home's chance of surviving a wildfire. Clearing overhanging vegetation or vegetation within a 5-foot radius can reduce risk significantly; Buildings that had at least half of the area within 5 feet of their home covered by vegetation were destroyed in a wildfire 78% of the time -- a rate 1.9 times higher than homes that had this area less than 50% covered by vegetation. In other words: having heavy vegetation (including bushes, trees, and shrubs) immediately around your home can nearly double the chance of destruction. This aligns with IBHS's home hardening and mitigation research, which highlights the value of removing fuel sources surrounding a home.

Some astute readers may be quick to point out that the risk of destruction for individual properties may still be high when vegetation covers less than half the area around the house. This is true. However, as mentioned, more than 1 out of every 3 properties involved in historical wildfires had more than 50% vegetation in at least one zone surrounding their home. In other words, by removing fuel around their homes, more than one-third of properties involved in wildfires could have reduced their chances of destruction by up to 50%. Going even further, properties with



Figure 3. (1) A home with low surrounding vegetation density that survived the Woolsey Fire, 2018. (2) A home with high vegetation density that was destroyed in the Tubbs Fire, 2017.

absolutely no vegetation up to 30 feet around their home had a destruction rate of just 24%, compared to 56% for properties with any vegetation in the same zone - a difference of more than **2x**.

While the 50% threshold was chosen for clarity and to highlight high-risk properties, **Table 2** demonstrates that wildfire risk is a gradient. Homes with low surrounding vegetation are still at an increased risk compared to homes with no surrounding vegetation, and homeowners and community leaders should make efforts to reduce vegetation coverage regardless of their 'starting point.'

Vegetation coverage 5-30ft from the structure	Destruction rate
0 - 10%	26.9%
Above 10%	46.8%
Above 30%	53.3%
Above 50%	62.0%
Above 70%	70.4%

Table 2: Structure destruction rate for varying vegetation coverage 5-30ft from the structure.

BUILDINGS

As discussed in the methodology section of this paper, the presence of structures magnifies the risk of destruction when the risk is already high due to other factors like vegetation. It probably does not surprise many readers that disconnected buildings alone are not very likely to lead flames to your doorstep. However, if flames are in proximity, structures are additional fuel that can draw the flames closer to the home.

Zone	Destruction rate Building present	Destruction rate No buildings present	Difference in likelihood of destruction
Area based on the rooftop outline	A building partly or completely within the zone	No buildings within the zone	Presence of buildings vs no buildings
0-30 ft from the structure	58.9%	34.3%	1.7x
30-100 ft from the structure	60.4%	31.2%	1.9x

Table 3. Risk reduction for properties in neighborhoods with moderate to high vegetation coverage (30% or more coverage within 30-100ft of the home) and buildings partly or entirely covering the zone, compared to no buildings within the zone.

As shown in **Table 3**, the risk is amplified for homes in areas with moderate-to-high vegetation coverage that are located in building-dense neighborhoods or have secondary structures close to their homes. Because most homeowners have no control over their neighbors' lots, homeowners in dense neighborhoods with high to moderate vegetation coverage must make efforts to clear vegetation and pay close attention to other fuel sources such as fences and yard debris. Homeowners with secondary structures such as sheds or gazebos should apply the same standard of vegetation clearance as they would to their primary home. Where possible, homeowners should also consider moving or removing secondary structures.

OTHER FACTORS

Over the past two decades, the best practices for new construction in the Wildland-Urban Interface (WUI) have advanced significantly. Effective techniques are being employed where defensible space can be extended well away from structures, and careful building design and material selection can significantly reduce wildfire risks. Yet 99% of Americans live in homes that were constructed over the past century—not recently constructed structures that reflect the newest building codes.

IBHS has laid out eight pathways with specific mitigation strategies for suburban neighborhoods through the [IBHS Suburban Wildfire Adaptation Roadmaps](#). These insights – including “must change” actions like addressing wood shake roofs, combustible siding, underdeck vulnerabilities, open vents, and combustible materials within 5 ft of the home – build on findings the fire protection community has published and reflects the best experimental and field research to date. One of the eight pathways identified in the Roadmaps concerns the home ignition zone and overall fuel management. The results presented here, using image analysis and elements of artificial intelligence, lend support to the concepts presented in that pathway of the Roadmaps. While these insights further increase our understanding of this difficult peril, and thus are a cause for optimism, wildfire remains a significant threat to many thousands of homeowners. To bend down the wildfire risk curve, the mitigation practices discussed herein must be used in concert with other mitigation/home hardening actions at the home and community level by many.

CONCLUDING REMARKS

Wildfire devastation and costs are accumulating, and insurers, policy-makers, and homeowners are looking for places to take action and how to start. This study shows that any effective plan begins by clearing vegetation close to your home, and moving outwards. Homeowners in high wildfire hazard areas can reduce the risk of property damage by nearly half by clearing the vegetation around the property across various defensible zones. Properties located in areas of high building density or properties that have secondary structures near their home must pay even closer attention to managing the vegetation on their property, as the structures exacerbate the risk of damage when there is vegetation present.

[Zesty.ai](#) and [IBHS](#) recognize that reducing the presence of fuel around your property is a sensible and attainable first step, but the conclusions of this analysis extend beyond that.

Homeowners need to both reduce the presence of fuel surrounding their home and leverage advice from the likes of IBHS to harden their structure against flames and embers. While the analysis presented in this study shows a material reduction in risk by reducing fuels, ~40% of properties that had low fuel density were still destroyed in a wildfire demonstrating the importance of other factors beyond the fuel immediately surrounding the property.

Community leaders need to spearhead and organize with local and national organizations that promote wildfire preparedness, because wildfire protection does not stop at the boundaries of a single property. Creating firebreaks by removing debris including dead leaves in alleyways is an example of impactful community effort.

Governments and regulators need to promote good homeowner behavior and disseminate information to their communities on the risks of uncontrolled wildfires. Wildfires will not go away, and it is also possible for wildfires to re-occur at the same location, since many underlying risk factors (including topography and wind direction) do not tend to change over time.

Insurance carriers need to focus on pathways to understand the specific risk and mitigation activities of individual properties. The scientific and modeling communities will continue to expand the analytical tools related to neighborhood-scale risk and other wildfire mitigation tactics. Collectively, such tools will better equip carriers to make insurance available and appropriately price the risk.



WILDFIRE FUEL MANAGEMENT AND RISK MITIGATION

Where to start?

The IBHS mission is to conduct objective, scientific research to identify and promote effective actions that strengthen homes, businesses and communities against natural disasters and other causes of loss. Learn more about IBHS at [DisasterSafety.org](https://www.DisasterSafety.org).



Increasingly frequent natural disasters, such as wildfires, floods and hurricanes devastated communities and drove \$2.2 Trillion in economic losses over the past decade. Zesty.ai uses 200Bn data points, including aerial imagery, and artificial intelligence to assess the impact of climate change one building at a time. Zesty.ai has partnered with leading insurance companies and property owners helping them protect homes, businesses and support thriving communities.



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Zesty.ai was named Top 100 Most Innovative AI Company in the world by CB Insights in 2020, and Gartner Cool Vendor in Insurance by Gartner Research in 2019. For more information visit: [Zesty.ai](https://www.Zesty.ai)