Risk Analysis

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Perceptions of Parcel–Level Wildfire Risk Differ Between Homeowners and Trained Assessors in Wildland–Urban Interface Communities Across the Western United States

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ABSTRACT

Wildfire risk mitigation on private property is central to reducing community wildfire vulnerability. Homeowners have control over many of the key factors that contribute to wildfire risk on their parcels, yet vulnerable conditions persist. One potential explanation is a misalignment between homeowners' and trained assessors' perceptions of parcel-level wildfire risk. Prior research has documented a "risk gap" in a single community wherein owners often underestimate their parcel-level wildfire risk; however, it is unclear whether such misalignments are widespread. This study replicates and expands previous research by examining the parcel-level wildfire risk gap in 38 wildland–urban interface (WUI) communities across the Western United States using paired data from household surveys and parcel-level wildfire risk assessments by trained assessors. We find that homeowners and assessors often perceive parcel characteristics differently. Homeowners may systematically mis-weight their importance, tending to underweight key controllable factors such as building materials and defensible space, leading to meaningful divergence from trained assessor ratings. Accordingly, we also find that homeowners generally underestimate overall parcel wildfire risk compared to trained assessors. These results suggest that even when homeowners recognize attributes on their parcels that contribute to wildfire risk, they may not fully grasp how much the attributes contribute to overall parcel risk, potentially failing to recognize the need to undertake meaningful mitigation actions. The findings from this study contribute to the broader natural hazards literature on expert-layperson risk perception gaps and offer insights for improving wildfire communication, education, and mitigation strategies in WUI communities.

1 | Introduction

Mitigation of wildfire risk on private property is broadly recognized as essential to addressing wildfire risks, as homes are both recipients and transmitters of fire. However, not all drivers of wildfire risk may be within a homeowner's control. Factors such as topography or the overall density of vegetative fuels in the surrounding landscape are often difficult or prohibitively expensive to change, and many occur beyond the boundaries of an individual residential property or parcel. In contrast, several key

parcel-level attributes that contribute to home ignition potential are within homeowners' control, including the building materials of a home, vegetation near the home, or combustible materials near the home. Together, these characteristics collectively define parcel-level wildfire risk, shaping the likelihood that a home will ignite and contribute to fire spread during a wildfire event.

Despite fire science providing clear guidelines for the mitigation of wildfire risk at the parcel level, fire-prone communities are characterized by residential parcels that lack mitigation up to the standards shown to reduce the risk of home ignition. One contributor to that shortcoming may be the divergence between homeowners' and trained assessors' perspectives of parcel conditions and wildfire risk, that is, a risk gap (Meldrum et al. 2015). A gap may arise from differences between the homeowners' and trained assessors' perceptions of the conditions of individual risk attributes on the parcel or from differences between perceptions of how an individual attribute contributes to their overall wildfire risk. If homeowners in fire-prone communities do not perceive that their parcel's conditions contribute to their wildfire risk, they may not perceive a need to take action to reduce risk.

Here, we examine whether a risk gap exists between homeowners' and trained assessors' perceptions of parcel attributes and overall wildfire risk conditions within 38 Western United States communities. This research replicates a similar analysis by Meldrum et al. (2015), which focused on one Colorado community and takes a deeper look at the implications with respect to parcel-level mitigation when a risk gap exists.

1.1 | Homeowner Risk Mitigation Actions

Wildfires in the Western United States are increasing in size, frequency, and severity (Dennison et al. 2014; Weber and Yadav 2020) and cost billions of dollars annually in management and losses (Thomas et al. 2017). As the fire-prone wildland–urban interface (WUI), where human development and wildland vegetation meet, expands (Radeloff et al. 2018), more homeowners are exposed to wildfire risk. Homeowners in these areas can take proactive mitigation actions to reduce the risk of a wildfire damaging or destroying their homes. However, if homeowners do not recognize the conditions on their parcels that contribute to wildfire risk or if homeowners fail to understand how much those conditions contribute to their overall parcel-level risk, they may not mitigate wildfire risk to standards that increase the chances of a home surviving a wildfire.

Fire science has shown that homeowners can take specific actions to reduce the chance that their homes are damaged or destroyed by wildfire. These actions include home hardening, which involves using ignition-resistant materials to reduce the likelihood of ignition (Cohen 2000; Knapp et al. 2021; Maranghides et al. 2013), and maintaining defensible space, which involves creating open space free of vegetation and nonvegetative combustible materials near the home to reduce the likelihood of fire traveling from nearby vegetation to the structure (Gibbons et al. 2012; Kolden and Henson 2019; Scott et al. 2016; Syphard et al. 2017). Structural modifications have been found to reduce wildfire risk to parcels by up to 40% and, when combined with vegetation modifications, to reduce risk by up to 75% (Czajkowski et al. 2020). Furthermore, proper parcel-level wildfire risk mitigation, or lack thereof, can also spill over to neighboring parcels (Butry and Donovan 2008; Kunreuther et al. 2023; Meldrum et al. 2022; Warziniack et al. 2019).

1.2 | Risk Perceptions and Risk Mitigation Uptake

Homeowners' decisions to mitigate their parcels are shaped by a complex set of interrelated factors. A substantial body of research finds that homeowners' wildfire risk perceptions are associated with mitigation actions (e.g., Brenkert-Smith et al. 2012; Champ et al. 2011a, 2011b; Dickinson et al. 2015; I. M. Martin et al. 2007; W. E. Martin et al. 2009; McFarlane et al. 2011; McNeill et al. 2013; Meldrum et al. 2019; Nelson et al. 2004; Talberth et al. 2006). In the broader natural hazards literature, risk perceptions themselves are related to factors such as sociodemographics, personal experience, and trust in authorities and experts (Schneiderbauer et al. 2021; Wachinger et al. 2013). Furthermore, interactions with wildfire management organizations (Dickinson et al. 2015) and education or outreach efforts (McCaffrey et al. 2011; Schulte and Miller 2010) are related to both risk perceptions and mitigation actions. Public outreach programs, especially those that connect fire agency personnel and homeowners, are central in fostering wildfire preparedness and acceptance of mitigation efforts (McCaffrey 2015).

Despite this, empirical evidence consistently shows that risk perceptions alone are often not sufficient predictors of mitigation activities (Champ et al. 2013; I. M. Martin et al. 2007; Olsen et al. 2017). A recent review by Cowan and Kennedy (2023) synthesizing 78 studies published between 2013 and 2022 identifies several key determinants of mitigation adoption, including risk perceptions (e.g., perceived likelihood or vulnerability), social connection and capital (e.g., neighbors' actions, trust in government and fire authorities), geospatial and land tenure characteristics (e.g., urban/rural, new/long-term residents), perceived effectiveness of mitigation measures, perceived responsibility, education and information (e.g., education programs), capacity (e.g., financial, time, physical abilities), demographics (e.g., age, employment), and regulatory context (e.g., homeowners associations). Mitigation also requires financial resources (Lee et al. 2022; Penman et al. 2017), which homeowners may not want or be able to use for this purpose. Consistent with the broader natural hazards literature, higher perceived risk does not necessarily translate into risk-reducing behavior (Anderson et al. 2024; Wachinger et al. 2013). Rather, risk perceptions are a necessary, but insufficient, condition for homeowners to take mitigation actions (McCaffrey et al. 2012), operating in conjunction with capacity, social norms, institutional trust, and perceived effectiveness of actions.

1.3 | The Risk Gap

Public perceptions of risk frequently diverge from expert assessments (Slovic 1987), including risk perceptions related to natural hazards (Antronico et al. 2019; Chowdhury and Haque 2011; Chowdhury et al. 2012; Lazo et al. 2000; Meldrum et al. 2015). Much of the literature related to measured wildfire risk

and homeowner perceptions finds that homeowners have a general understanding of landscape conditions. For example, homeowners with parcels with higher fire risk perceive higher consequences of wildfire (Brenkert-Smith et al. 2013), homeowners in heavily vegetated areas have higher risk perceptions (Blanchard and Ryan 2007), and wildfire risk perceptions are positively correlated with hazardous conditions predicted by fuel models (Olsen et al. 2017). However, homeowners' perceptions of wildfire risk on their parcels may not align with more objective measures of wildfire risk or professional assessments (Schulte and Miller 2010). Furthermore, the natural hazards literature notes a gap between expert and layperson assessments of risk across domains from geo-hydrological (Antronico et al. 2019) to climate change effects (Chowdhury et al. 2012; Lazo et al. 2000) to wildfire (Meldrum et al. 2015).

In the case of parcel-level wildfire risk, a risk gap may exist for two reasons. First, a gap may arise from differences between the homeowners' and trained assessors' perceptions of the conditions of individual risk attributes on the parcel. For example, a trained assessor may observe less defensible space surrounding the home than a homeowner due to differences in their understanding of defensible space or due to differences in how accurately they can estimate distance. Second, a gap may also arise between homeowners' and trained assessors' perceptions of how an individual attribute contributes to their overall parcel wildfire risk. For example, a homeowner may know they have a combustible fence attached to their home, but not understand whether or how much that combustible attachment increases parcel-level wildfire risk. Either of these circumstances could lead to a wildfire risk gap in which homeowners underestimate or overestimate the wildfire risk on their property compared to a trained assessor. Such gaps can be problematic. If homeowners fail to recognize the relative risk posed by different parcel attributes, they may misallocate their time and financial resources to attributes that contribute little to overall wildfire risk. In addition, if homeowners underestimate the overall parcel-level wildfire risk, they may fail to engage in sufficient mitigation actions or fail to prepare sufficiently for evacuation.

Meldrum et al. (2015) use data from one WUI community in Western Colorado (collected using the same approach as the data for the present study) and find that judgments about both overall and specific attributes of parcel-level wildfire risk diverge significantly between homeowners and professional assessors. According to Meldrum et al. (2015), differences in attribute ratings come from both subjective (e.g., density of vegetation) and objective (e.g., distance measures) aspects of parcel characteristics, and differences in overall ratings relate, in part, to differences in how attributes are aggregated into an overall risk rating. Furthermore, the authors find that the direction of disagreement is not consistent across measures. They find that for many parcel attributes, homeowners underestimate parcel-level risk compared to trained assessors (i.e., overall risk, ignitability of the home's exterior and deck, the distance to flammable vegetation and other combustibles, and the visibility of the home's address), while for other attributes, homeowners overestimate risk (i.e., level of background fuels and width of driveway). Understanding the differences in perspectives of homeowners and trained assessors can help improve communication and education efforts that increase community wildfire resilience.

1.4 | Research Goals and Replication

This study replicates the Meldrum et al. (2015) approach that demonstrated a risk gap in one Colorado WUI community. The replicated approach is implemented on a substantially larger paired dataset of household surveys and rapid parcel-level wildfire risk assessments from 38 WUI communities in the Western United States. We investigate how self-reported assessments of individual parcel attributes differ between homeowners and trained assessors, how homeowners implicitly aggregate parcel attributes into overall risk, and how homeowners' perceptions of overall wildfire risk differ from overall risk ratings generated by trained assessors. While replication is uncommon in risk studies, replication studies can confirm the reliability and validity of original findings (Soderberg and Errington 2019; Zwaan et al. 2018). Furthermore, replication studies can have many goals, such as verifiability, robustness, repeatability, and generalization (Freese and Peterson 2017). Replication strengthens the foundation of scientific knowledge, promotes transparency, and helps identify errors or exaggerations in previous studies. In an era where reproducibility concerns have challenged many fields (e.g., Pashler and Wagenmakers 2012), replication serves as a critical tool for maintaining scientific integrity and progress.

2 | Study Area and Data Sources

2.1 | The Wildfire Research (WiRē) Approach

This study leverages a dataset compiled by the Wildfire Research (WiRē) Center,[1] originating from multiple projects conducted in partnership with wildfire mitigation and education organizations (e.g., fire departments, regional wildfire councils, state forest services, nongovernmental organizations) in select WUI communities in six Western states (Alaska, Colorado, New Mexico, Utah, Washington, and Wyoming) between 2020 and 2024 (WiRē 2025). Study communities were selected by partnering practitioner organizations to inform their programmatic needs, often motivated by the goal of better understanding the communities' wildfire risk. The boundaries of each community were determined by a combination of geographic and social factors (including county assessor naming, fire protection service areas, and local knowledge). All study communities face high wildfire risk, but they vary in many ways, including exposure to wildfire hazards, the extent of existing wildfire education and outreach programs, and existing levels of parcel- or community-level mitigation efforts. A map of community locations is shown in Figure 1.

All projects followed a standardized data collection procedure involving a rapid parcel-level wildfire risk assessment performed by trained assessors for all residential parcels within a study community and a mailed household survey delivered to the mailing address on record for all assessed parcels (described in more detail in Champ et al. (2021)). Both the risk assessment and household survey included parallel measures on wildfire-relevant parcel risk attributes. Assessors were from various organizations with expertise or backgrounds in fire or natural resources. All assessors, regardless of their existing expertise, received a series of trainings that included (1) training and orientation on wildfire behavior and home structure ignitions, (2) training on how to use the data collection tool, and (3) training on how to complete

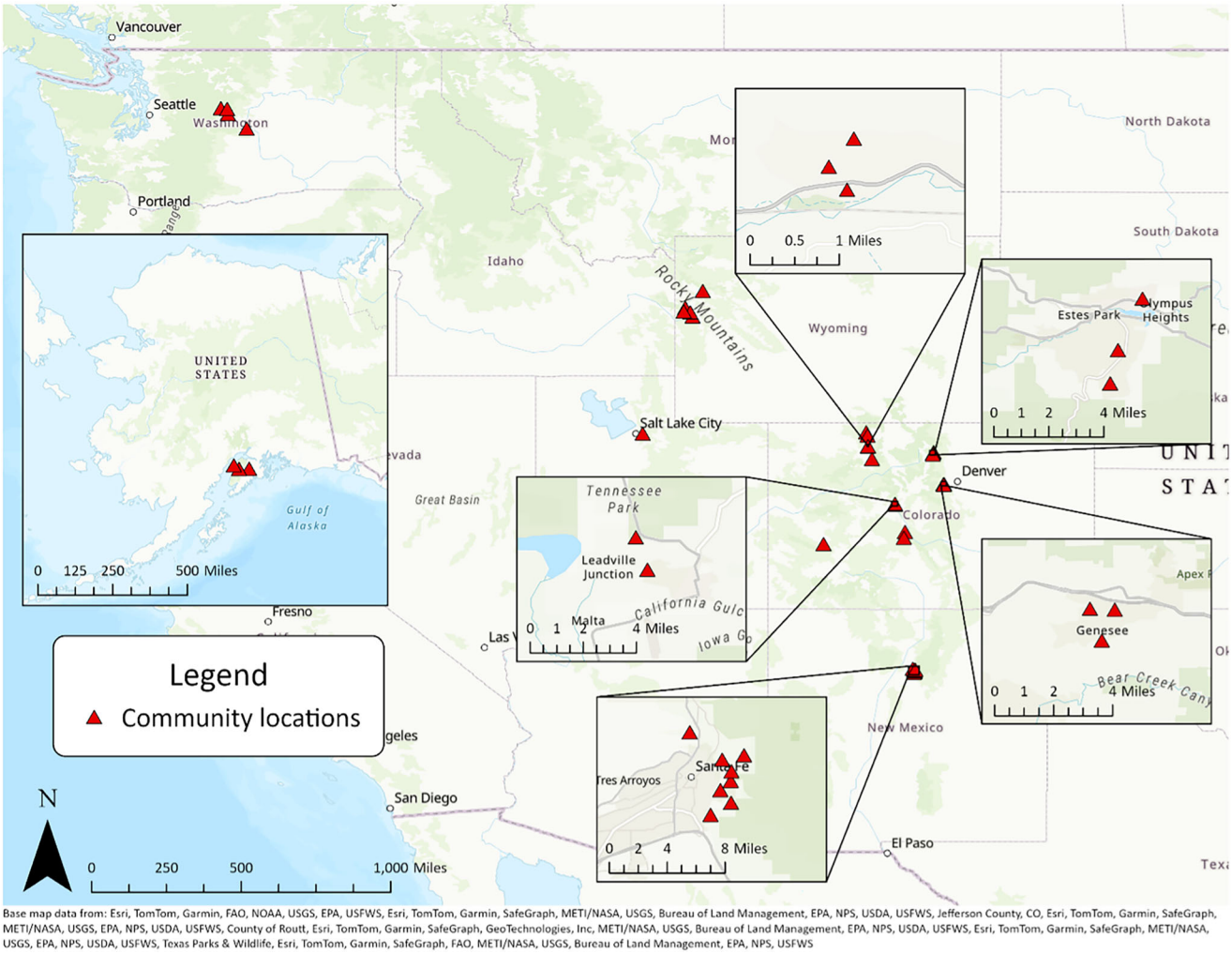

FIGURE 1 | Map showing points representative of the locations of Wildfire Research (WiRē) study communities in the Western United States. Inset maps show zoom-ins on communities in close proximity to one another for clarity. The map image is the intellectual property of Esri and is used herein under license.

the risk assessment, including a detailed description of risk assessment attributes and response categories. Training occurred just before data collection. This process helped to standardize the implementation of the methodology across projects and assessments. Assessments were performed in person from the road, and while the risk assessment is not without limitations, it is the method used to rapidly evaluate all homes in a given area, not unlike a structural triage assessment before or during a wildfire event (Heeren et al. 2023). The household surveys were administered using a modified Dillman approach (Dillman 2011) involving four mailings: a letter introducing the project, a survey packet including a postage-paid return envelope, a reminder/thank you postcard, and a second survey packet. In addition to questions about parcel-level attributes, household surveys collected information on respondents' wildfire attitudes and risk perceptions, as well as numerous other wildfire experiences and demographic characteristics. Household survey data were collected and maintained in compliance with the Human Subjects protocol.[2]

2.2 | Parcel-Level Wildfire Risk

WiRē rapid parcel-level wildfire risk assessments (performed by trained assessors) characterize wildfire risk to a particular parcel by measuring four broad categories of vulnerability: home ignition potential, defensible space, background conditions, and access for emergency response and evacuation. The WiRē risk assessment is composed of 13 attributes that measure these vulnerabilities. These attributes are illustrated in Figure 2. Table 2 further describes these attributes and the categorical levels by which each is measured. Assessors selected a closed-ended categorical response option for each attribute while observing the parcel in the field. Subsequently, individual attribute ratings are aggregated into an overall risk score (a continuous number on a 0-to-1000-point scale), in which each attribute is weighted (by the "Points" shown in Column 4 of Table 2) to reflect its relative contribution to parcel-level wildfire risk, which we refer to as "WiRē weights."[3] These risk scores are then translated into an overall risk rating

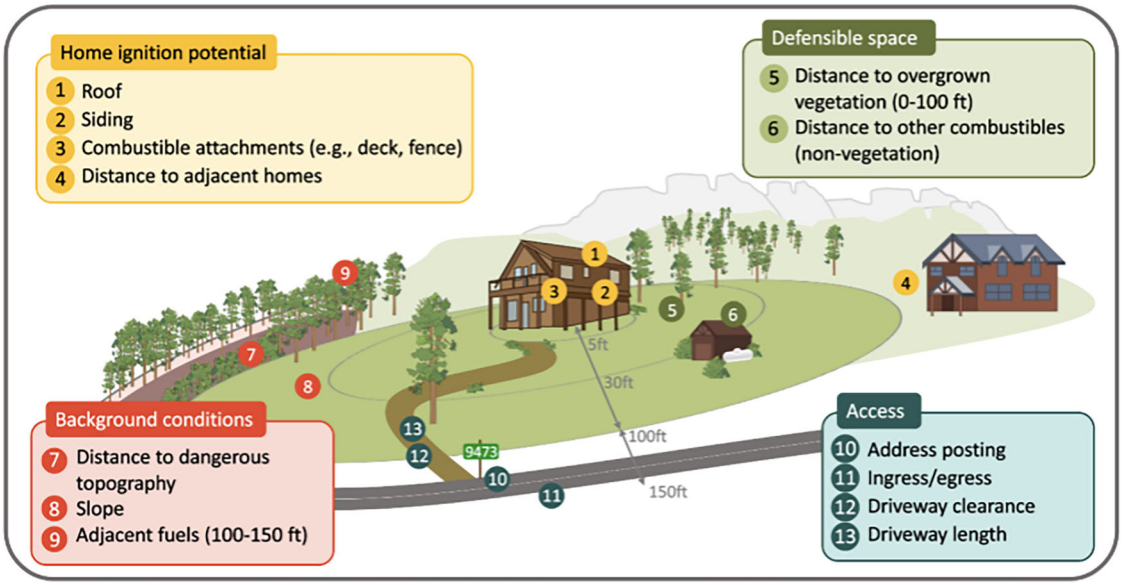

FIGURE 2 | Wildfire Research (WiRē) rapid parcel-level wildfire risk assessment: A visual guide.

TABLE 1 | Responses to selected risk perception and mitigation survey questions. Data are from household surveys conducted by multiple partners and supported by the Wildfire Research (WiRē) Center in select communities across the Western United States, 2020–2024.

Survey or assessment question	Survey item	Levels	Percent	*N*
How much do you agree or disagree with the following statements about wildfire?	My property is at risk of wildfire	Strongly disagree or disagree	18%	2170
		Neutral	23%	
		Strongly agree or agree	59%	
What do you think is the chance that a wildfire will be on your [community] property in the next 12 months?	N/A	< 50%	81%	2166
		≥ 50%	19%	
Have you done any of the following wildfire-related activities?	Removed large or dense vegetation near my [community] property (ex. cleared/pruned trees, shrubs, brush)	No	15%	2190
		Yes	85%	
	Regularly cleared my roof and gutters of leaves and pine needles	No	23%	2137
		Yes	77%	
	Regularly mowed and raked around my [community] home	No	15%	2177
		Yes	85%	
	Made my [community] home more fire resistant (ex. replaced roofing, siding, added hardscaping)	No	53%	2168
		Yes	47%	

TABLE 2 | Rapid parcel-level wildfire risk assessment and household survey ratings of individual parcel attributes associated with wildfire risk. Data are collected by multiple partners and supported by the Wildfire Research (WiRē) Center in select communities across the Western United States, 2020–2024 ($N = 2217$).

Variable	Description	Levels	Points	Assessment	Survey
Attributes homeowners have more control over					
roofType[a]	Roofing material	Noncombustible (tile, metal, or asphalt shingles)	0	96%	98%
		Combustible (wood/shake shingles)	300	4%	2%
attachType[a]	Combustible attachments (e.g., balcony, deck, fence)	No combustible attachments	0	15%	23%
		Combustible attachments present	100	85%	77%
vegetationDistance[a]	Closest distance from house to overgrown, dense, or unmaintained vegetation	More than 100′	0	5%	34%
		30′ to 100′	50	19%	42%
		5′ to 29′	75	46%	21%
		Less than 5′	100	30%	3%
combustiblesDistance[a]	Closest distance from house to combustibles other than vegetation (e.g., lumber, firewood, propane tank, hay bales)	More than 30′ or no combustible items	0	17%	43%
		5′ to 30′	40	35%	45%
		Less than 5′	80	49%	12%
sidingType[a]	Exterior siding covering majority of home	Noncombustible (brick, cement, stucco)	0	22%	30%
		Log or heavy timbers	35	10%	14%
		Wood or vinyl	70	68%	56%
addressVisibility	House number posted at driveway entrance	Posted and reflective	0	28%	32%
		Posted and not reflective	5	57%	38%
		Not posted or not visible	10	15%	31%
drivewayClearance	Driveway meets horizontal and vertical clearance standards	Meets standards for height and width clearance	0	62%	60%
		Meets one, but not both standards (height or width)	5	32%	34%
		Does not meet either standard (height or width)	10	6%	6%
Attributes homeowners have less control over					
closeHome[a]	Closest distance from house to adjacent homes	More than 100′	0	46%	60%
		30′ to 100′	50	40%	28%
		10′ to 29′	100	10%	9%
		Less than 10′	200	4%	3%

(Continues)

TABLE 2 | (Continued)

Variable	Description	Levels	Points	Assessment	Survey
topographyDistance[a]	Distance to dangerous topography (e.g., ridge, steep drainage, or narrow canyon)	More than 150′	0	60%	72%
		50′ to 150′	25	20%	18%
		Less than 50′	50	20%	10%
vegetationType[a]	Dominant vegetation type on parcel 100′ to 150′ from home	Light—grasses	10	17%	22%
		Medium—light brush and/or isolated trees	20	47%	51%
		Dense—dense brush and/or dense trees	40	36%	27%
slope	Slope (steepness) of parcel	Gentle—less than 20%	0	60%	51%
		Moderate—between 20% and 45%	10	29%	38%
		Steep—greater than 45%	20	12%	12%
numberOfRoads[a]	Number of roads that could be used to get out of community	Two or more roads in/out	0	36%	41%
		One road in/out	10	64%	59%
drivewayLength	Length of driveway	150′ long or less	0	66%	60%
		Longer than 150′ with turnaround for fire truck	5	24%	29%
		Longer than 150′ without turnaround for fire truck	10	11%	11%

Note: All Wilcoxon matched-pairs signed-rank tests of different distributions comparing Assessment and Survey distributions are significant at the 0.001% level except for drivewayClearance.

[a]Homeowners underestimate risk compared to risk assessment by trained assessors.

(*assessmentRiskRating*) measured by five qualitative categories: Low, Moderate, High, Very high, and Extreme.[4] Table 2 also indicates which parcel attributes homeowners have more or less control over, offering insight into potential leverage points for risk mitigation.[5]

The WiRē household survey asks a parallel set of questions to the WiRē rapid parcel-level risk assessment attributes. Each survey question has closed-ended response categories that coincide with the attribute level on the risk assessment (as detailed in Table 2). The survey response options are descriptive of the attribute itself, rather than being about "risk perceptions" per se; thus, the survey asks how the respondent views their parcel's characteristics, not their risk perceptions at an attribute level. The "Points" or attribute weights shown in Column 4 of Table 2 are not provided in the survey. After the 12 survey questions,[6] homeowners are told that "*Properties in your community are assessed for overall wildfire risk based on the items asked about in questions 3.1–3.12 above*," then asked, "*What do you think is your property's current overall wildfire risk rating?*" Their response, *surveyRiskRating*, is measured using the same five categories that align with risk assessment ratings *(assessmentRiskRating)*: Low, Moderate, High, Very high, and Extreme. We can identify a risk gap by comparing differences between homeowners' and assessors' perceptions of parcel-level conditions.

3 | Results

3.1 | Descriptive Statistics and Risk Perceptions

We first examined survey measures related to homeowners' general wildfire risk perceptions and mitigation activities. Table 1 displays the percentage of responses from over 2000 homeowners from select WUI communities between 2020 and 2024. The majority (59%) of homeowners agreed or strongly agreed that their parcel is at risk of wildfire, although 41% disagreed or were neutral to that statement, despite all homeowners living in areas at high risk of wildfire. Nineteen percent of homeowners believed there was a 50% or greater chance of a wildfire being on their parcel in the next 12 months.[7]

A majority of homeowners reported taking action to mitigate wildfire risk on their parcel. Most homeowners reported actions to maintain defensible space around their home (85%

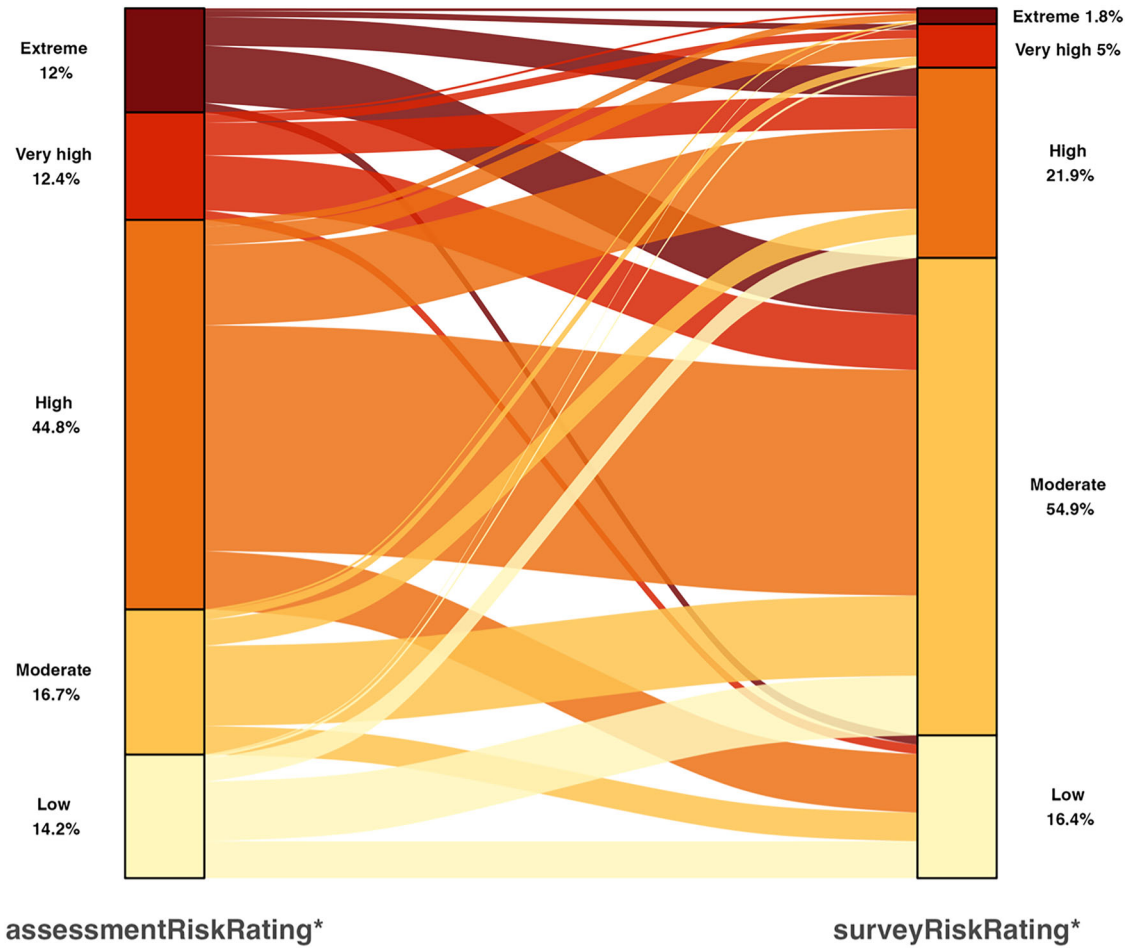

FIGURE 3 | Rapid parcel-level wildfire risk assessment and household survey ratings of overall parcel wildfire risk. Data are collected by multiple partners and supported by the Wildfire Research (WiRē) Center in select communities across the Western United States, 2020–2024 ($N = 2217$). *Wilcoxon signed rank test demonstrates a significant difference between paired *assessmentRiskRating* and *surveyRiskRating*.

of homeowners reported removing vegetation on their parcel, 85% reported regularly mowing and raking, and 77% reported regularly clearing their roof and gutters of leaves and pine needles), while less than half reported home hardening actions (47% of homeowners reported making their home more fire resistant) (Table 1).

3.2 | Risk Assessment Data and the Risk Gap

When we examined the individual parcel attributes that comprise a risk assessment, we found substantial differences between homeowners' and assessors' perceptions of parcel-level conditions. Figure 3 visualizes the differences in overall parcel risk ratings, comparing the aggregate assessment ratings using assessors' (*assessmentRiskRating)* and households' (*surveyRiskRating)* perceived conditions. This visualization illustrates the proportion of homeowners who exhibit a risk gap, along with the magnitudes of these misalignments.

Table 2 reveals a notable discrepancy between perceptions of parcel-level wildfire risk conditions made by WUI homeowners and trained assessors. For individual parcel attributes, Wilcoxon matched-pairs signed-rank tests reject the null hypotheses that homeowners' and assessors' perceptions of conditions follow the same distribution for 12 of 13 attributes assessed. For nine of these attributes, homeowners tend to underestimate their wildfire risk, reporting a less risky level, compared to trained assessors: *roofType*, *attachType*, *vegetationDistance*, *combustiblesDistance*, *sidingType*, *closeHome*, *topographyDistance*, *vegetationType*, and *numberOfRoads*. For three of the attributes, homeowners tend to overestimate their wildfire risk, reporting a riskier level, compared to trained assessors: *addressVisibility*, *slope*, and *drivewayLength*. Only one attribute, *drivewayClearance*, is not significantly different between homeowners' and assessors' perceptions. It is notable that of the top six most heavily weighted attributes, five (all except *closeHome*) are generally within the control of homeowners, and homeowners underestimate all of these compared to trained assessors. Although the *assessmentRiskRating* was based on the weighted sum of the individual attributes described above, the *surveyRiskRating* was directly asked as a single question asking the homeowners' current overall wildfire risk rating on the 5-point scale from Low to Extreme. For overall risk, homeowners tend to underrate their parcel's risk compared to assessor ratings. Less than a quarter of homeowners' overall risk ratings align with those of trained assessors (24%), with the most common pattern being a one-category difference. Forty-five percent of homeowners in our

sample were rated as High wildfire risk by trained assessors, while a majority of homeowners self-reported their wildfire risk as Moderate (55%). In addition, 12% of parcels were rated Extreme by trained assessors compared to only 1.8% of households self-reporting their risk as Extreme. We perform a Wilcoxon signed-rank test and determine that there is a significant difference between paired household and assessor risk assessment ratings, demonstrating that homeowners underestimate the risk of their parcels compared to trained assessors.

3.3 | Aggregation of Risk-Related Parcel Attributes Into Overall Risk Perception

Our findings indicate that, on average, homeowners' perceived overall parcel-level risk is lower than that of assessors. However, assessors determine a parcel's overall parcel risk rating using the WiRē weights—a precise point-based weighting system developed by experts informed by fire science. In contrast, households were asked to consider these individual attributes when estimating their parcel's overall wildfire risk without having access to the weighting of attributes used by assessors. We hypothesize that this underestimation of risk may be a result of how homeowners mentally weigh the 13 individual risk attributes when determining their overall wildfire risk rating compared to trained assessors.

To evaluate this hypothesis, we convert our qualitative risk rating to a numeric value (*surveyRiskRatingNum*) based on the midpoint of the point value range of the overall risk perception rating (*surveyRiskRating*) chosen by respondent *i* (e.g., if a respondent rated their parcel as Low risk, this corresponds to a risk score of 0–250 points on the 1000 point scale, so their *surveyRiskRatingNum* would be 125 points). We then regress each household's *surveyRiskRatingNum* on the weighted sum of each household's chosen risk-related attribute rating, where the weighting corresponds to the point values assigned to each attribute level (shown in the fourth column of Table 2):

$$surveyRiskRatingNum_{ic} = \sum_{(j=1)}^{13} \left(\beta_j \cdot \gamma_j \cdot [attribute]Survey_{ijc}\right) + \alpha_c + \epsilon_{ic}$$

γ_j represents the weighting value for attribute *j* as determined by wildfire experts. $[attribute]Survey_{ijc}$ represents each individual parcel-level attribute response by household *i* in WUI community *c*. α_c represents community fixed effects, and ϵ_{ic} is the error term. β_j represents the coefficient of interest for each risk attribute. We report *p* values for both the null hypothesis $H_0 : \beta = 0$ (Table 3, column 3) and for the null hypothesis $H_0 : \beta = 1$ (Table 3, column 4). Therefore, column three tells us the statistical significance of respondent *i*'s weighting of each attribute into their overall risk (traditional *p* values), while column four tells us whether the average implicit weight households place on each attribute is equivalent to the WiRē weights. In other words, according to the *p* values in column three, any statistically insignificant results indicate that homeowners do not implicitly assign any weight to that corresponding attribute. In contrast, according to the *p* values in column four, any statistically significant difference from one means that homeowners implicitly assigned less (< 1) or more (> 1) weight to the corresponding attribute when determining the overall risk level compared to the WiRē weights. We did not explicitly ask homeowners what weight they assign to each attribute when determining their overall risk; we use this comparison to assessors' ratings to determine what attributes homeowners think contribute to their overall risk or not.

Table 3 column three demonstrates that homeowners recognize many, but not all, of the factors that contribute to wildfire risk on their property. Coefficients on eight of the 13 risk attributes are significantly different from zero, indicating that those attributes play a role in how homeowners rate their overall risk. Of these eight attributes, five are controlled by households (*roofType*, *vegetationDistance*, *combustiblesDistance*, *sidingType*, and *drivewayClearance*), while three of them are not controlled by households (*topographyDistance*, *vegetationType*, and *numberOfRoads*). However, five attributes show no relationship with homeowners' risk ratings *(attachType, addressVisibility, closeHome, slope*, and *drivewayLength)*, suggesting that these factors are overlooked when homeowners assess their own risk.

Column 4 of Table 3 further shows that even when homeowners do consider an attribute relevant to their wildfire risk, they may not weigh it as strongly as the WiRē weights. Seven attributes are both significantly different from zero (Column 3) and significantly different from one (Column 4), implying that, on average, homeowners believe these attributes contribute to their overall wildfire risk rating; however, they are misaligned with the WiRē weights on how important these attributes are in determining their overall risk rating. In most cases, homeowners underweight key risk factors. Homeowners considered *roofType* to contribute 11% of the points (300) to the overall risk that the WiRē risk assessment would have assigned, *vegetationDistance* to contribute 61% of the points (100), *combustiblesDistance* to contribute 20% of the points (80), *sidingType* to contribute 15% of the points (70), and *topographyDistance* to contribute 47% of the points (50). For two attributes, *vegetationType* (40 points) and *numberOfRoads* (10 points), homeowners tended to overweight these attributes compared to the WiRē weights by 129% and 113%, respectively. Comparisons of coefficients in Table 3 to results from Meldrum et al. (2015) can be found in Table A1.

Taken together, these results indicate that differences between homeowner and assessor risk ratings are driven not only by disagreement about on-the-ground conditions but also by how those conditions are combined into an overall risk judgment. In other words, even when homeowners recognize relevant risk factors, they misjudge their relative importance, often underestimating attributes that are critical for reducing home ignition potential. This divergence has important implications for risk communication and mitigation efforts, as it indicates that improving awareness alone may be insufficient without addressing how homeowners weigh different sources of risk.

4 | Discussion

Using data from 38 WUI communities across the Western United States, we find a consistent gap between homeowners' and trained assessors' perceptions of parcel-level wildfire risk. These findings build on past work by Meldrum et al. (2015), showing

TABLE 3 | Coefficients and standard errors estimated for the community-level fixed effects ordinary least squares (OLS) model for *surveyRiskRatingNum* as a function of individual survey attribute responses. Data are from household surveys conducted by multiple partners and supported by the Wildfire Research (WiRē) Center in select communities across the Western United States, 2020–2024 ($N = 2217$).

	Coefficients and standard errors	p-value for $H_0 : \beta = 0$	p-value for $H_0 : \beta = 1$
Attributes homeowners have more control over			
roofType	0.106	0.030	0.000
	(0.047)		
attachType	0.073	0.151	0.000
	(0.050)		
vegetationDistance	0.613	0.000	0.000
	(0.090)		
combustiblesDistance	0.200	0.005	0.000
	(0.067)		
sidingType	0.153	0.046	0.000
	(0.074)		
addressVisibility	1.243	0.151	0.774
	(0.849)		
drivewayClearance	3.423	0.015	0.070
	(1.337)		
Attributes homeowners have less control over			
closeHome	−0.030	0.764	0.000
	(0.101)		
topographyDistance	0.473	0.018	0.006
	(0.192)		
vegetationType	2.289	0.000	0.000
	(0.269)		
slope	0.731	0.087	0.519
	(0.416)		
numberOfRoads	2.128	0.000	0.000
	(0.286)		
drivewayLength	1.104	0.211	0.905
	(0.868)		
Num. obs.	2217		
Num. groups	38		
R^2	0.245		
Adj. R^2	0.228		

that the discrepancy between homeowners' and assessors' judgments is not isolated to a single community but rather a widespread phenomenon across varying geographies and contexts. Our expanded dataset allows for the generalization of this risk perception gap and provides greater insight into where and how these perceptions diverge.

A majority of WUI homeowners in our study perceive some level of wildfire risk to their parcels, and most (85%) report that they have taken mitigation actions such as removing large or dense vegetation from their parcels. Despite this reported engagement, our analysis finds that a risk gap arises in part due to differences in homeowners' and assessors' perceptions of the conditions of individual risk attributes on a parcel and in part due to a misalignment of how individual risk attributes contribute to overall parcel-level wildfire risk. Together, these differences result in households underestimating their overall parcel wildfire risk compared to trained assessors. While risk perception is only one of several factors influencing mitigation behavior, this underestimation may shape how homeowners prioritize and sustain risk-reducing actions by reducing perceived urgency or necessity. As such, gaps between homeowners' and trained assessors' evaluations of wildfire risk may contribute to the challenges in advancing mitigation uptake, alongside

other challenges such as capacity, social norms, and institutional factors (Cowan and Kennedy 2023).

We find that this underestimation is especially pronounced for attributes that fire science identifies as critical factors in a structure's ability to survive a fire event. Homeowners implicitly underweight the importance of several key attributes, many of which are within their control, such as roofing and siding materials, distance to combustible vegetation and other materials, and distance to dangerous topography, often attributing less than 20% of the weight that the WiRē risk assessment assigns to that attribute. If a homeowner perceives their overall risk to be lower than a trained assessor deems it to be based on the framework of the WiRē risk assessment, the homeowner may lack the motivation or urgency to undertake sufficient mitigation or evacuation actions to lower their parcel's wildfire risk.

These findings have implications for wildfire risk communication and mitigation programs. First, education and outreach can help focus not only on raising general awareness about wildfire risk but also on the specific attributes and their relative contributions to an overall parcel-level wildfire risk. More information could be provided to households outlining the risks posed by characteristics such as proximity to neighboring homes or the slope of one's parcel, as homeowners do not factor in these attributes into their overall perceptions of wildfire risk. Following this insight could help tailor communication, build trust, and strengthen community resilience to extreme events (Chowdhury et al. 2012; Bradford et al. 2012).

Detailed risk assessments and household surveys collected by social scientists are a resource for local wildfire practitioners to understand these risk gaps. Without precise information on how homeowners perceive the characteristics of their own parcel, local wildfire educators may interpret low levels of mitigation or parcels with risky conditions as apathy or indifference. However, homeowners may think their mitigation efforts are sufficient and need professional feedback about whether their efforts are up to standards that have been proven to change wildfire behavior and improve the chances of home survival during a wildfire. Analyzing homeowner risk perceptions and observed conditions together can allow targeted education programs to address these gaps at an attribute level, addressing the root causes of wildfire risk gaps in their communities.

Our multi-community dataset masks important local variation across study areas. Differences in outreach history, wildfire events, and community organization may all influence the degree and nature of the perception gap in any particular community. Future work could investigate whether the presence, size, and direction of a risk gap are influenced by the availability of education or outreach programs in WUI communities, shedding light on the effectiveness of these programs as tools for improving mitigation and preparedness. Additional research could examine whether closing the risk gap translates into actual changes in mitigation behavior, allowing for stronger inference about the causal link between risk perception, understanding of parcel-level attributes, and action. Finally, longitudinal data collection could allow researchers to assess how risk perceptions and mitigation behaviors evolve over time, particularly following wildfire events, policy changes, or targeted interventions, providing valuable insights for designing more effective, evidence-based wildfire risk reduction strategies.

5 | Conclusion

Private mitigation actions play a role in reducing wildfire risks to individual parcels and creating resilient communities. A substantial body of research shows that homeowners' perceptions of wildfire risk on their parcels are one important factor, among many others, that influences mitigation behavior (Brenkert-Smith et al. 2012; Champ et al. 2011a, 2011b; Cowan and Kennedy 2023; Dickinson et al. 2015; I. M. Martin et al. 2007; W. E. Martin et al. 2009; McFarlane et al. 2011; McNeill et al. 2013; Nelson et al. 2004; Talberth et al. 2006). Therefore, when a gap exists between homeowners' and assessors' perceptions of parcel-level risk, communities could be left underprepared. These gaps in risk perceptions can have serious consequences as households that underestimate their risk may not invest in critical mitigation measures or prepare for evacuation.

Using paired household surveys and parcel-level risk assessments from 38 WUI communities in the Western United States, we identify and investigate systematic gaps between homeowner and assessor perceptions of wildfire risk. The breadth and diversity of this multi-community dataset, rare in the broader hazards and disaster literature, allow us to move beyond localized case studies and generate more generalizable insights into the conditions under which risk gaps emerge across varied WUI contexts. Our findings show that homeowners and trained assessors often perceive parcel characteristics differently. In addition, even if perceived identically, homeowners generally underestimate the contribution to overall parcel-level risk from many of these attributes, including roofing and siding materials and proximity to vegetation. Due to these misalignments, homeowners tend to underestimate their overall parcel-level wildfire risk compared to trained assessors. This underestimation suggests that many homeowners may not fully recognize the vulnerability of their parcels or feel sufficiently motivated to take meaningful mitigation actions or evacuation preparations to reduce their risk. Ultimately, knowledge of this gap can be used by wildfire practitioners to better engage with homeowners and strengthen community wildfire resilience throughout the Western United States.

Author Contributions

Kelly Wallace: writing – original draft, writing – review and editing, formal analysis, conceptualization, investigation, methodology, visualization, data curation. **Grant Webster**: writing – original draft, writing – review and editing. **Hannah Brenkert-Smith**: funding acquisition, writing – review and editing, supervision, conceptualization. **Patricia A. Champ**: funding acquisition, writing – review and editing, supervision, conceptualization. **Colleen Donovan**: writing – review and editing, data curation. **Carolyn Wagner**: writing – review and editing, data curation. **Christopher M. Barth**: writing – review and editing, conceptualization, data curation. **Josh Kuehn**: writing – review and editing, data curation. **Suzanne Wittenbrink**: writing – review and editing, data curation. **James R. Meldrum**: writing – review and editing, methodology, supervision, conceptualization.

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Disclosure

The findings and conclusions in this report are those of the authors and should not be construed to represent any official USDA determination or policy. The household surveys described in this report were organized and implemented by nonfederal partners and were not conducted on behalf of the U.S. Geological Survey. Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the United States government.

Conflicts of Interest

Hannah Brenkert-Smith reports a relationship with the Wildfire Research (WiRē) Center that includes board membership. The other authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are protected by IRB data use standards and can only be used through a data sharing agreement with the Wildfire Research (WiRē) Center.

Endnotes

[1] https://wildfireresearchcenter.org/.

[2] Survey documentation included the language, "*By returning the survey, you are acknowledging you understand your rights as a study participant and providing consent to participate*."

[3] Risk attribute weights were developed by wildfire experts at the WiRē Center based on the current fire science literature. The weighting is an automatic feature of the attribute selected, while the assignment of the overall risk rating occurs during data cleaning and processing.

[4] Wildfire risk scores are mapped into five risk categories based on the distribution of risk scores within the full dataset of WiRē risk assessments at the time the study took place.

[5] We acknowledge that homeowners may not always have the ability to modify aspects we deem within their control, such as when Home Owner Association regulations restrict certain actions or when living in multifamily housing limits individual choices; our designation is meant to provide a general categorization for overall comparison rather than for strict interpretation.

[6] Two of the attributes (*drivewayLength* and *drivewayClearance*) are asked in a two-part question, 13 attributes are measured in 12 questions.

[7] Wildfire Risk to Communities metadata shows burn probability (annual, modeled) ranges from 0 to 0.13 nationwide (Scott et al. 2020).

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Appendix

TABLE A1 | Comparison of regression coefficients with Meldrum et al. (2015). Data are from household surveys conducted by multiple partners and supported by the Wildfire Research (WiRē) Center in select communities across the Western United States, 2020–2024 ($N = 2217$).

	Coefficients and standard errors		
	Wallace et al. (2026)	**Meldrum et al. (2015)**	**Overlapping confidence intervals**
	Attributes homeowners have more control over		
roofType	0.106[a]	0.08[a]	Yes
	(0.047)	(0.14)	
attachType	0.073[a]		—
	(0.050)		
deckType		1.21	—
		(0.49)	
vegetationDistance	0.613[a]	0.70[a]	Yes
	(0.090)	(0.15)	
combustiblesDistance	0.200[a]	1.24	No
	(0.067)	(0.42)	
sidingType	0.153[a]	0.09[a]	Yes
	(0.074)	(0.13)	
addressVisibility	1.243	1.16	Yes
	(0.849)	(0.98)	
drivewayClearance	3.423		—
	(1.337)		
	Attributes homeowners have less control over		
closeHome	−0.030[a]		—
	(0.101)		
topographyDistance	0.473[a]	0.29[a]	Yes
	(0.192)	(0.18)	
vegetationType	2.289[a]	1.70[a]	Yes
	(0.269)	(0.21)	
slope	0.731		—
	(0.416)		
numberOfRoads	2.128[a]	1.65	Yes
	(0.286)	(0.82)	
drivewayLength	1.104		—
	(0.868)		
Num. obs.	2217	256	
Num. groups	38	1	
R^2	0.245	—	
Adj. R^2	0.228	—	

Note: Coefficients and standard errors are reported from Table 3 compared to similar estimates from Meldrum et al. (2015). Some risk attributes have been revised or updated in recent risk assessments and surveys; therefore, comparison of these items is not practical. R^2 and adjusted R^2 are not reported in Meldrum et al. (2015).

[a] *p* values significantly different from a value of 1 at the 95% confidence level (contrary to typical *p* values, which are tested against equaling zero).