Abstract:

Societal risks associated with natural hazards are largely determined by human decision-making and risk mitigation behaviors. While much is known about individual risk perception, there is a gap in understanding interpersonal risk production (IPR), defined as the decision to prepare for an environmental threat/ hazard which influences the risk faced by others. This study considers IPR for two forest-based hazards: wildfires and invasive insects. We consider the role of psychological distance on threat perception and IPR. We surveyed private landowners in Colorado and Massachusetts, two states with high incidence of wildfire, and insects, respectively. Results suggest that the threat of both wildfire and invasive species hazards may be relatively distant (particularly temporally) to private forest owners and thus not conducive to promoting present action. Land managers and policymakers can better leverage efficacy beliefs if they can reduce the perceived psychological distance of the forest hazards that landowners face.

1. Introduction

Forest ecosystems face many threats, including changing climatic conditions, invasive insect and plant species, land use conversion to agriculture and urban development, and natural hazards (Liu et al., 2016; McDowell & Allen, 2015). Natural hazards are generally defined as naturally occurring phenomena presenting risk to the environment and humanity (Tobin, 1997). Although naturally occurring, anthropogenic contributions to climate change increase the likelihood and intensity of these phenomena (Bradshaw et al., 2016; Finley & Chhin, 2016). Furthermore, the magnitude of environmental and societal risk associated with natural hazards is largely determined by human decision making and risk mitigation behavior (Martin et al., 2009).

The interpersonal requirements of environmental hazard management present additional challenges. One landowner's decision not to prepare for environmental threats may increase the risk faced by others. Measures taken by landowners to mitigate risks associated with natural hazards often do not reflect the magnitude of the consequences (Carmi & Kimhi, 2015). It is suggested that this is due to psychological barriers impeding landowners' ability to comprehend the severity of environmental threats (Carmi & Kimhi, 2015). Moreover, landowner risk mitigation measures may or may not be influenced by the likelihood that their actions will increase risk faced by others, either because they are not aware of the increased risk potential, or because they do not care.

1.1 Theoretical Background

Psychological distance (PD) is derived from field theory, first proposed in 1951 (Lewin 1951). It has been further explained by construal-level theory stating that as an object becomes further removed from direct experience, the mental construal of the object becomes more abstract (Trope & Liberman, 2010). Psychological distance refers to the cognitive gap in perception between oneself and distant events (Carmi & Kimhi, 2015; Huff et al., 2017; Trope & Liberman, 2010). The four dimensions of PD describe the extent to which a threat is perceived as close in space (geographical distance), probable (hypothetical distance), close in time (temporal distance) and having personal implications (social distance) (Trope and Liberman, 2010). Research suggests that these dimensions are interrelated in the context of threat perception. Perceived closeness in one dimension causes greater perceived closeness in other dimensions and vice versa (Carmi & Kimhi, 2015; Spence et al., 2012; Trope & Liberman, 2010;).

Environmental decision-making research uses PD to explain risk perception and mitigation behavior (Jones et al., 2017). Humans tend to discount the value of psychologically distant events, explaining the dilemma of environmental complacency among policymakers and landowners (Carmi & Kimhi, 2015). The abstract nature of environmental issues leaves them largely perceived as unthreatening compared to economic and security issues (Carmi & Kimhi, 2015; Jones et al., 2017). Risk perception has been found to directly influence mitigation behavior (Martin et al., 2009). In other words, psychologically close events are perceived as more threatening than distant events and are more likely to be actively managed as a result.

Interpersonally-produced risks are influenced by and interdependently affect all members of a population (Keren & Roelofsma, 1995; Fornasari et al., 2019). In an interconnected society, the decision to prepare or not prepare for an environmental threat or hazard influences the risk faced by others. This is especially true in mixed-ownership and parcelized landscapes where ecological components are subdivided between properties (Nyland, 1996). Because of this, effective risk mitigation depends heavily on collaborative management and cross boundary cooperation (Bergmann & Bliss, 2004; Fischer & Charnley, 2012). Existing research finds that social interaction across ownership boundaries significantly

influences risk perception and mitigation behavior (Brenkert-Smith et al., 2014). The degree to which a landowner believes their behavior affects neighboring properties may relate to social distance (Jones et al., 2017).

1.2 Literature Review

Forests are relied upon for recreational opportunities, commodities, and other ecosystem services (Aukema et al., 2011; Paini et al., 2016). Given that an estimated 36% of United States forest land is controlled by family forest owners, it is important to understand their decision-making behavior (Butler et al., 2020). Owners are thought to be responsible for demonstrating environmental stewardship and sustainable ecosystem management to preserve the benefits provided by forest land. Specifically, they are responsible for evaluating the effects of their management decisions in the context of a broader spatial and temporal scale (Nyland, 1996).

There are two natural hazards that may require a more active approach to private forest land management. The first is natural or anthropogenically-caused wildfires. Naturally occurring, low-intensity wildfires benefit forest ecosystem stability by facilitating regeneration and nutrient cycling (Morrison et al., 2001). However, wildfire frequency and intensity has been increasing because of climate change and rapid development of the wildland-urban interface (Brenkert-Smith et al., 2012; Radeloff et al., 2018; Steel, 2014;). Misguided management efforts favoring fire suppression accompanied by drought conditions have led to a rise in fuel availability, putting homeowners and forest land at risk of property damage, public health decline, fatality, erosion, and biodiversity loss (Brenkert-Smith et al., 2012; Dickinson et al., 2015; Steel, 2014). Government agencies such as a Department of Environmental Quality or a Department of Natural Resource Management work with private landowners to manage vegetation using prescribed burns (Schultz et al., 2018; Steel, 2014). This method prevents fuel buildup while allowing forests to reap the natural benefits of fire (Steel, 2014). Landowners in high risk areas are encouraged to take proactive measures on their property to mitigate potential damage associated with wildfire. Modifying structural aspects of the home in addition to monitoring and managing surrounding

vegetation influences property vulnerability in the event of an outbreak (Dickinson et al., 2015; Martin et al., 2009). This is known commonly as the creation of defensible space.

A second potentially devastating hazard are invasive and non-native insects and pathogens. Invasive insects are amongst the greatest threats to ecosystem biodiversity and present serious ecological and social consequences (Aukema et al., 2011). Globalization and international trade facilitate the spread of invasive pests by providing pathways for invasion, including contaminated commodities and stowaway species (Hulme, 2009). A lack of natural predators allows invasive pests to out-compete native species, disturb the food web and cause devastating damage to vegetation and agriculture (Bradshaw, 2016; Crowder and Snyder, 2009). Globally, the United States suffers the greatest agricultural loss due to invasive species (Paini et al., 2016). The financial burden of invasive species management is primarily carried by private landowners and municipal authorities (Aukema et al., 2011). Management expenses result from timber loss, recreational damage, pesticide application, health decline and lowered property value (Aukema et al., 2011; Bradshaw, 2016). Pesticide use, heat treatment, field inspections and regulated wood-product movement and storage are common management strategies (Hulme, 2009). Although management efforts are most effective in the early stages of detection, this is restricted by a lack of non-destructive early detection methods (Finley & Chhin, 2016).

1.3 Objectives

Despite a growing body of research examining the role of PD in explaining environmental behavior, there is a lack of research connecting PD theory in private landowner decision making, and even less research using PD theory in forestry (Huff et al., 2017). Most research exploring this theory in the context of natural resource management broadly focuses on climate change (e.g., Spence et al., 2012). Our study aims to expand upon construal-level theory research by describing environmental risk perception and mitigation behavior amongst private landowners within the context of PD. The objectives of this study were to: 1) Characterize the past experiences of private landowners in fire-prone and invasive insect-prone communities with these respective hazards; 2) Determine if and how

interpersonally-produced risks were mitigated; and 3) Determine if and how psychological distance affected private landowner propensity to mitigate interpersonally-produced risk. Our results provide insight into the decision-making process of landowners experiencing environmental threats. Understanding how PD manifests in landowners' experience with, perceptions of and responses to environmental risk will aid in developing strategies to better encourage engagement in mitigation behavior.

2. Method

2.1 Study Sites

The survey was implemented in 9 Massachusetts towns that had experienced invasive pest outbreaks in the decade prior: Boylston, Charlemont, Haverhill, North Andover, Pittsfield, Princeton, Shrewsbury, Townsend, and Worcester. It was also implemented in El Paso and Boulder counties in Colorado, which have experienced multiple wildfires in the past decade. Massachusetts was chosen for the invasive insects survey due to multiple insect outbreaks and potential for familiarity with invasive insects. Likewise, Colorado was chosen because wildfire is a common natural hazard and landowners in the sample had a greater chance of having experienced wildfire than those living in other arid parts of the western U.S. The two study sites were chosen to represent two natural hazards that have great potential to alter the ecosystem services forests provide, and to see if similarities exist across landowners living in different regional and cultural settings.

2.2 Survey Participants

Two survey instruments were developed and tailored to the specific natural hazard of interest; invasive insects for landowners in Massachusetts and wildfire for Colorado. For both surveys, property tax records for counties that had recently experienced either a fire or an invasive insect outbreak were gathered. A random sample of landowners was drawn from property tax records, and for owners that

owned at least 1 acre of land. The study was approved by both the [institutions removed for peer review] Institutional Review Board (IRB# 2016-3164).

We were able to recruit 505 participants for the Colorado survey and 374 for the Massachusetts survey out of 2,000 surveys mailed to each respective state. After removing undeliverable and returned surveys (n=76 for Colorado and n=34 for Massachusetts), our adjusted response rate was 26% for Colorado and 19% for Massachusetts. Due to these response rates, a non-response bias check was performed. First, a third mailing of one page of the survey was sent to all non-responders, with a letter indicating that this was a non-response check. We received 29 and 50 responses, respectively, and none of the variables from the check were statistically significantly different from responders, with one exception. Those who responded had slightly smaller land ownerships than the non-responders. A second non-response bias check was done by performing a phone number match by property addresses, yielding 48 valid phone numbers. We were able to perform a phone interview with 10 individuals and found that their responses also did not statistically differ from the original survey.

Several participants were dropped from further analyses due to not providing an identification pin or failing to respond to subsequent items after providing either their pin or property type. Additionally, three participants were removed from the Massachusetts sample for large parcel sizes (> 400 acres) as we determined these were statistical outliers. This left a total of 470 participants in the Colorado sample and 320 respondents in the Massachusetts sample used in analyses.

2.3 Measures

We developed a wide range of topic-relevant items to assess how aspects of psychological distance may manifest in both Colorado and Massachusetts landowners' experience with, perceptions of and responses to salient environmental risks. The following topics and subsequent measures are highlighted in the results below: personal experience with environmental risks; factors influencing landowners' perceptions of response efficacy; influence of risk type on landowners' environmental risk perceptions; factors affecting Massachusetts landowners' familiarity with invasive pests; perceived

likelihood of experiencing future environmental risks; actions taken to reduce susceptibility to environmental risks; and, communication and information seeking behaviors. Additionally, we collected information on several socio-demographic and landowner-characteristics. For the Massachusetts sample, landowners responded to items relative to their experience with and perceptions of invasive species, whereas Colorado landowners were explicitly asked questions relative to their experience with and perceptions of wildfires.

Responses are categorized by topic, rather than by survey. Note that while the surveys include several overlapping items and themes, many of the items used to assess landowners' experience with, perceptions of, and responses to either invasive pests or wildfires are unique to each survey, respectively. Due to missing data based on item non-response, response sample sizes are noted in the main text or figure text for items whose sample size deviates from the total N. All analyses were performed in R and figures were created using the *ggplot2*, *likert* and *dplyr* packages (Bryer & Speesschneider, 2016; R Core Team, 2016; Wickham, 2009).

One of the primary topics of interest was to examine how and to what extent landowners understand the effects of their management decision-making on proximate others. That is, we examine how risk management decisions taken on one's own property are perceived as influencing others nearby. Understanding the impact of one's decision-making and behavior on others ties to hypothetical distance and, to a further extent, assesses the social/geographical aspects of psychological distance as well. Thus, to explore this topic we asked participants in both samples to what extent they perceived that activities on their own wooded land affect their neighbors' wooded land (1 = *not at all*; 5 = *greatly*).

In addition to assessing landowners' perceived influence on others' property as a function of various factors, we also explored how the type of risk (e.g., wildfire vs. invasive pests) landowners primarily experience may differentially influence their environmental risk perceptions. For instance, wildfires present a more significant risk to humans compared to invasive pests, which primarily threaten species of trees and vegetation. Thus, we examined how state-level (e.g., type of risk) differences may influence landowners' level of confidence in their own ability to mitigate environmental risks; the effort

they had taken to reduce their susceptibility to risk; consideration of future consequences; and dispositional risk. Consideration of future consequences was composed of a two-item composite (e.g., 'I think it is important to take warnings about negative outcomes seriously even if the negative outcome will not occur for many years').

Several items were developed to assess how aspects of psychological distance may materialize relative to landowners' perceptions about the likelihood of experiencing future environmental risks (e.g., wildfire or new invasive pests). These items were designed to highlight and measure both the temporal as well as the social/geographical dimensions of psychological distance. To achieve this, the temporal dimension was operationalized by experiencing a risk either next year (near) or within the next five years (distant), while the social/geographic dimensions were assessed by the risk presenting on either one's own property (near) or else on neighboring property (distant).

2.4 Analyses

To further explore relationships among key study variables, a number of regression analyses were performed. In both samples, models were run to examine how and to what extent different demographic factors and other environmental risk-related factors, including personal experience, influence landowners' perceptions of how risk management decisions taken on one's own property influence others nearby and behavioral intentions. While no formal hypotheses were made regarding whether different landowner characteristics and personal experience would influence landowners' perceptions, we did explore how these factors may differentially influence landowners' perceptions of response efficacy, communication intentions (CO sample only), and information-seeking intentions (MA sample only). Predictors included property size, retirement status, age, gender, education, consideration of future consequences, dispositional risk, concern, confidence, effort, personal experience with environmental risks, likelihood of experiencing risk on own property in the present, familiarity (MA sample only), and past communication behaviors (CO sample only). Selection of predictors was based on items known to influence forest landowner attitudes and behaviors (Floress et al. 2019). Variables with extremely low variance, such as race, were not included in modeling.

To model, several variables were re-coded for clarity and interpretation. To assess Massachusetts landowners' experience with invasive pests, an index variable was created that summed across landowners' experience with invasive pests and dead trees on their property (continuous, 0-4, n = 249, M = .76, SD = .99). For the Colorado sample, past communication behavior was coded as a dichotomous item (0 = reported no past communication behaviors (n=144); 1 = reported engaging in at least one past communication behavior (n=317), n/a = 9). Similarly, communication intention, the dependent variable, was coded as both a dichotomous (0 = no intention to communicate (n=111); 1 = at least one intention to communicate (n=346, n/a = 13)) and continuous item (continuous, 1-3, n = 346, M = 1.76, SD = .83) for the Colorado sample. For the Massachusetts sample, information-seeking intentions, the dependent variable, was coded as both a dichotomous item (0 = no intention to seek information (n=51), 1 = at least one intention to seek information (n=249), n/a = 20) and continuous item (continuous, 1-5, n = 249, M = 1.66, SD = .93). In both samples, the continuous items only included those who had reported their intention to engage in at least one communication or information-seeking behavior. The descriptive statistics presented here include all responses before adjusting for item-non-response in the models.

3. Results

3.1 Respondent Characteristics

Landowner respondents in both Colorado and Massachusetts were predominantly White, had a normal distribution of income level, and were well educated. A majority of the sample had either a Bachelor's or Advanced degree (Table 1). The average parcel size in Colorado was 4.12 acres, and 6.47 acres in Massachusetts in the sample (Table 1). Landowners in Colorado had acquired their land between 1905 and 2017 and landowners in Massachusetts had acquired their land between 1945 and 2016. The majority of landowners in both states were either joint or individual owners and were residential owners (Table 1).

[Table 1 about here]

3.2 Descriptive Statistics

3.2.1 Personal experience with environmental risks

Most Colorado respondents indicated witnessing forested land soon after a wildfire burn (81.5%, n = 467), while only a limited number of respondents experienced wildfire that burned on their own land (11.3%, n = 465) and/or had structures on land damaged or lost because of a wildfire (7.0%, n = 465). Additionally, about a quarter of respondents indicated that wildfire burned on their neighbor's land (26.2%, n = 465), while a larger number of respondents indicated that smoke from wildfire has made them physically uncomfortable or affected their or another's health in the household (52.6%, n = 467) and that smoke has in some way inconvenienced them (e.g., diminished scenery or caused outdoor plans to be canceled, 68.1%, n = 466, Table 2). Direct experience with wildfire—either on their own or neighboring properties—among our sample of Colorado landowners was limited. Similarly, Massachusetts landowners' experience with invasive pests was minimal (Table 2).

[Table 2 about here]

3.2.2 Factors influencing landowners' perceptions of response efficacy

For Colorado landowners, 13.7% (n=63) felt their actions would have no effect on their neighbors' wooded land, while nearly half of respondents felt their actions would moderately or greatly affect their neighbors' wooded land. For Massachusetts landowners, a third (33.3%, n=99) of respondents felt their actions would have no effect while a quarter of respondents felt their actions would moderately or greatly affect their neighbors land.

3.2.3 Influence of risk type on landowners' environmental risk perceptions

For Colorado landowners, level of effort was weakly positively correlated with confidence ($r = 0.18$, $p = < 0.001$). For Massachusetts landowners, level of effort was moderately positively correlated with confidence ($r = 0.33$, $p = <0.001$). Figure 1 depicts the results of these analyses using violin plots. Colorado landowners expressed elevated levels of effort taken to reduce the risk, more confidence in reducing the risk, and considered future consequences at a higher level than Massachusetts landowners.

[Figure 1 about here]

3.2.4 Familiarity, Concern about experiencing environmental risks, and relationship with neighbors

A series of items were asked to gauge participants' level of concern with experiencing environmental risks on both their own and others' property. For the Colorado sample, participants indicated their level of concern (1 = *no concern*; 5 = *great concern*) about wildlife occurring on their wooded land (concern own; M = 3.57, SD = 1.13, n = 436, not applicable = 24) as well as wildfire occurring on public lands within a mile of their property (concern public; M = 4.03, SD = 0.99, n = 434 , non applicable = 21). For the Massachusetts sample, three items assessed landowners' level of concern for experiencing an outbreak of Hemlock Woolly Adelgid, Asian Longhorned Beetle, and Emerald Ash Borer on their property (1 = *no concern*; 5 = *great concern; 6 = not applicable*). The three items were combined into a composite (alpha = .87; M = 3.26, SD = 1.20, n = 279, 'not applicable' response option not included). Additionally, we asked Massachusetts landowners how familiar they are with the concept of invasive species (1 = *not at all familiar,* 5 = *extremely familiar*). Overall, respondents expressed a moderate level of familiarity with the concept (*M* = 3.38, *SD* = 1.10, n = 320). Participants in both samples also indicated their relationship with their neighbors by selecting all that apply for items such as, 'I have a professional relationship with all of my neighbors', 'We speak periodically but aren't close', 'I have a social relationship with some of my neighbors', 'I do not know my neighbors', among others. A dichotomous variable was created to capture participants' relationship with their neighbors (0 = no relationship, 1 = some relationship). For both samples, the vast majority of participants indicated having some relationship with their neighbors (n_{CO}= 421; n_{MA} = 269) compared to having no relationship (n_{CO}= 31, non $disclosure_{CO}$= 18; n_{MA} = 21, non $disclosure_{MA}$= 30).

3.2.5 Perceived likelihood of experiencing environmental risks

Overall, participants' responses suggest that on average Colorado landowners viewed experiencing a wildfire as a less likely reality compared to Massachusetts landowners who expressed more moderate levels of experiencing new invasive species (Figure 2). A similar trend emerged in each sample with respect to both the temporal and social/geographical dimensions of psychological distance. Response rates among Massachusetts and Colorado landowners revealed a higher likelihood for experiencing temporally distant events (e.g., occurring in the next five years) compared to more proximate events (e.g.,

next year) overall. Furthermore, landowners across both samples (and for both temporally near and distant events) reported that experiencing risks on one's own property is less likely than experiencing risks on neighboring properties.

[Figure 2 about here]

3.2.6 Actions taken to reduce susceptibility to environmental risks

Figure 3 displays a range of respective actions Massachusetts and Colorado landowners have taken to reduce their susceptibility to environmental risks on their property within the past five years. Massachusetts landowners indicated whether they had engaged in activities such as applying pesticides, planting pest resistant species and/or working with neighbors to remove pests, among others. The highest proportion of respondents indicated having engaged in no risk-reducing activities over the past five years, whereas fewer numbers of respondents reported having engaged in the other actions. More than half of Colorado landowners reported having limbed up trees, removed woody debris from the ground, and thinned trees, while fewer numbers indicated that they used mechanized or hand equipment to control undergrowth, and/or created and maintained fuel breaks. Even fewer respondents indicated that they conducted prescribed burns, purchased insurance and/or planted fire-resistant trees.

[Figure 3 about here]

3.2.7 Communication and information-seeking behaviors

While more than half of Colorado respondents indicated that they had talked with nearby property owners, only a third of respondents indicated that they had worked with neighboring property owners to mitigate their risk to wildfire (Table 3). In the Massachusetts survey, respondents indicated whether they intended to receive information or advice about invasive species from various sources over the next five years (n = 300). A little over half of respondents indicated that they would conduct an online search (54.0%), followed by talk to neighboring landowners (26.3%), participate in workshops or information sessions (24.7%), contact a natural resource professional (15.7%), other plans to get information (11.3%), talk to non-neighboring landowners (10.0%), talk to their family (7.3%). About 13.7% of respondents indicated having no plans to get information or advice about invasive pests.

[Table 3 about here]

3.3 Modeling

Ordinal logistic regressions were run to assess the relationship between selected predictors and landowners' response efficacy in both samples (see Table 4). Concern for wildfire occurring on one's own wooded land, perceived likelihood of experiencing wildfire on their own property, past communication behavior and age significantly predicted response efficacy for Colorado landowners. Concern and perceived confidence in ability to mitigate invasive pests on one's own land significantly predicted response efficacy for Massachusetts landowners.

[Table 4 about here]

For the Colorado sample, a binomial logistic regression was run to examine the relationship between predictors and the dichotomous communication intention variable, followed by an ordinary least squares regression to examine the influence of predictors on the continuous communication intention variable (see Appendix Table 1). Concern for wildfire occurring on their own wooded land and past communication behaviors significantly predicted the dichotomous communication variable. For the communication intention index, the model explained 19% of the variance (adj. R^2=.14). Whether a land owner was retired, perceived confidence in their own ability to mitigate wildfire on property, past communication behaviors, and age significantly predicted intention to communicate as an index. Age and past communication behaviors emerged as the predictors with the greatest relative importance (lmg = .029). Similar analyses were performed for the Massachusetts sample and information-seeking intentions (See Appendix Table 2). Gender and consideration of future consequences predicted information seeking when treated as a dichotomous variable. For the information seeking intention index, the model explained 24% of the variance (adj R^2=.15). Concern was the only significant predictor of information seeking (lmg = .062).

4. Discussion

342 This study of forest landowners in Colorado and Massachusetts sheds new light on key factors
343 that affect how landowners think about and perceive risks to their forested lands, the role of psychological
344 distance in shaping interpersonally-produced risks, and factors that affect perceived response efficacy
345 with respect to mitigating two potential forest hazards. Looking across both study areas and hazard types,
346 we find both consistency and divergence with respect to the distribution and prediction of these key
347 outcome variables. These mixed findings reinforce the need for psychologically-informed yet place-
348 specific studies of risk perception and issue engagement in the context of private lands management and
349 decision-making (Calkin, Cohen, Finney, and Thompson, 2014).
350 Across both study areas and hazard types, we find that concern for wildfire occurring on one's
351 own wooded land, perceived likelihood of experiencing wildfire on their own property, past
352 communication behavior, age, concern and perceived confidence in ability to mitigate invasive pests on
353 one's own land are related to increased perceptions of response efficacy. Additionally, in the case of
354 perceived risks from invasive species specifically (Massachusetts sample), we find that core ownership-
355 related demographic variables (i.e., ownership type, year of acquisition, experience on own land,
356 experience on neighboring land) additionally predict response efficacy. Given recent findings showing
357 that perceived efficacy is particularly important in promoting pro-environmental action when distance to
358 the threat is perceived (or framed) as close rather than distant (Chu & Yang, 2020), our results suggest
359 that land managers, policymakers and conservation advocates can better leverage efficacy beliefs if they
360 can find ways to reduce the perceived psychological distance of the forest hazards that landowners face.
361 This is especially important as our results also suggest that the threat of experiencing both wildfire and
362 invasive species hazards may be relatively distant to private forest owners and thus not conducive to
363 promoting present action.
364 Landowners perceived that the likelihood of experiencing temporally distant events was higher
365 (e.g., more likely to occur in the next five5 years versus next year). This may indicate an unwillingness to
366 believe that a hazard will occur soon, but that it is inevitable at some point in the future. Literature
367 suggests there may be situations in which increasing temporal distance is predictive of greater

consideration of impacts on others (e.g., when perceptions of personal threat are high, greater temporal distance may make it easier for people to manage their emotional responses and take measured action, e.g., McDonald, Chai and Newell 2015). Additionally, literature on risk perceptions related to natural hazards finds that personal experience and trust correlate with risk perception, but with varying direction (negative or positive) and minimal evidence for causality (Siegrist 2021). One review in particular describes a paradox: - individuals with high risk perception may still choose not to personally prepare themselves for a hazard (Wachinger et al., 2012).

The majority of MA landowners indicated no risk mitigation action taken in the past five years, yet showed higher levels of anticipated impact. Most of the Colorado landowners, in contrast, had taken entry-level risk mitigation action in the past five years (e.g. thinned trees, remove woody debris from ground), but showed lower levels of anticipated impact. Although we did not specifically categorize or scale actions based on level of difficulty or effort, these findings suggest that most Colorado landowners primarily engaged in entry-level risk reduction behaviors. Conversely, most Massachusetts landowners have yet to undertake any activities on their land for the purpose of reducing their risk to invasive pests. This may indicate that landowners believe that fire preparedness is worth at least minimal effort, while invasive pest risk mitigation does not pose a severe enough risk to engage in entry-level behaviors. Landowner response (e.g. behaviors) to invasive species risk may relate to their ownership objectives (Norlund & Westin, 2011), the anticipated severity of the insect outbreak, the location of the woodland, and pest awareness (Boyd et al., 2013; Nielsen-Pincus et al., 2015). This may be a result of differing hazard types. It is also important to note that the cost of mitigation is not the same between these two hazards:low-cost options for pest mitigation are limited to some chemical applications, but even these are costly when scaled to multiple acres. Pre-salvage harvesting is also quite costly and changes the structure and composition of the forest in ways that many landowners are unwilling to entertain. Conversely, creating defensible space is time intensive, but low cost and requires less specific skills/certification (e.g, pesticide application license or harvesting equipment). More involved mitigative actions (e.g, prescribed

burning) do require skill, equipment, and certification, which may also explain why these actions were less likely than the entry-level actions seen in the survey.

There may also be differing beliefs about the effectiveness of actions on preventing the hazard. Existing literature demonstrates that proactive private landowner invasive insect prevention and management is rare (Ma et al., 2018) and that any mitigative actions tend to occur among those who are actively working with a forestry professional. Additionally, actions occur at an individual scale, when a coordinated landscape-scale approach is required to actually prevent invasive species spread (Niemic et al., 2017). In the wildfire context, previous research details the positive impact of defensible space and prescribed burning for landowners (e.g., Nelson et al., 2005; Sisante et al., 2019; Syphard et al., 2014), but these actions are similarly at the individual/household level, despite the regional and landscape-scale nature of wildfires.

Perceived effort and confidence in reducing risk were correlated for both samples, but descriptively were different. Colorado landowners exerted more effort to reduce the risk, and had more confidence in reducing the risk. They considered future consequences at a higher level than Massachusetts landowners. So, even though there was a positive correlation, the risk of wildfire appeared to be less distant than that of invasive pests. We find that landowners with the low-level construal may have led to increased effort to reduce the hazard.

There were also similarities between both landowner groups, suggesting that some of the trends were hazard/risk agnostic. Both Massachusetts and Colorado landowners had a higher perceived likelihood of experiencing environmental risk occurring on their neighbor's property versus their own property. There was also a higher perceived likelihood of experiencing geographically/socially distant events. Research on psychological distance suggests that perceived social distance to others affected by our decisions (e.g., highly valued next-door neighbor vs. unknown neighbor across town) may affect people's motivation to engage in actions that produce or moderate risks for themselves (Chandran & Menon 2004). As perceived social distance decreases, decision-makers should generally be more sensitive to risk-related externalities produced by their own behavior, as outcomes that accrue to others are

increasingly experienced as occurring to the self as well (e.g., Cialdini et al., 1997), and we found this to be the case.

The present findings suggest a possible entry point for intervention aimed at increasing risk awareness and mitigation action is to leverage pre-existing willingness and ability to see risks faced by nearby others. Risks faced by those around us may be less threatening to discuss, but these discussions may eventually move towards how those risks could affect the target actor. Additionally, there is support for building peer-to-peer networks of landowners as this will reduce social distance and potentially increase confidence in ability to mitigate risk. Limited research suggests that landowners who are involved in a broader community of landowners are more likely to act on forest health issues (Molnar,et al., 2007).

4.1 Study limitations and future research

Colorado survey respondents indicated minimal direct experience with wildfire, which limited our ability to relate wildfire experience with other factors. There was low variability in demographics in our dataset, but this is true in nearly all forest landowner research unless a concerted effort is made to actively recruit among non-white, younger landowners. There was also low variability with respect to engagement with one's neighbors. Respondents had mainly positive interactions. Without asking this same question of a larger sample of individuals that are not forest landowners, we do not know if this unique to forest landowners, or an interesting finding more generally. There was an issue of item non-response in our dataset, which we could not control in a mail-based survey. Generally, our response rates were characteristic of mail survey research, and forest landowner survey research more specifically (Stedman et al., 2019).

Future research could test PD interventions on the likelihood of risk mitigation actions in both settings - a high impact, lower probability hazard setting (e.g., wildfire) and a lower impact, higher probability hazard setting (e.g., forest pests). Moreover, future research could examine how messaging risk reduction for nearby (adjacent) neighbors could increase willingness to take personally costly actions.

Finally, research could use natural interventions such as a new pest outbreak or a major wildfire and re-measure communities after these major events to determine if mitigation actions were taken and if PD was reduced in the affected communities.

5. Conclusion

Relatively little attention has been paid to interpersonal dynamics of risk mitigation efforts on private lands. The current findings suggest more effort is needed to uncover how these factors might promote and/or inhibit greater uptake of risk mitigation efforts by private landowners in the face of diverse hazards facing both landowners and their properties. Critically, our results point the way towards several potentially fruitful targets for future intervention, including perceptions of response efficacy and confidence with respect to mitigating risk, interpersonal relationships with geographically close others (i.e., neighbors), and perceived psychological distance regarding the timing and socio-spatial distribution of future hazards and impacts. Each of these factors could be amenable to relatively easy, straightforward interventions in the context of private landowner decision-making and conservation and should thus be a near-term focus for natural resource managers.

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6. References

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