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Social fragmentation and wildfire management: Exploring the scale of adaptive action

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1. Introduction

One overarching goal of United States fire management focuses on fostering human populations who can "adapt" to wildfire as an unavoidable, reoccurring process operating in the landscapes where they live. The goal of creating "fire adapted communities" is generally taken to mean that human populations can effectively prepare for, respond to and recover from wildfire events by reducing significant losses to important values, minimizing the need for suppression resources, and allowing fire to play a natural role in wildland ecosystems [113,34]. Yet adaptation in any given place is not just a product of potential future action surrounding wildfire or natural resource management. Research or practice also demonstrate how the legacy and ongoing functioning of human actors living in fire prone lands—including settlement patterns, agreement about landscape management practices, and coordination of suppression activities—can all influence the underlying conditions (e.g. fuel type, continuity, invasive species) dictating how fire operates across landscapes [22,102,103]. All of this implies a need to better understand how the interactions between the variety of landowners, officials, and land managers operating in many landscapes can influence the structure of "communities" and their collective ability to "adapt" to wildfire at larger, ecosystem-level scales [73,76,92]. The research presented here engages the interplay between social processes and landscape-level fire management by focusing on the ways that the diversity of landowners or land managers interacting in landscapes may influence broader fire management goals and approaches.

Cross-cutting lessons from existing research indicate that managing wildfire in social-ecological systems will require action at multiple scales of human society (e.g. local community, county government, federal agencies, etc.) [31,95,97]. It must also aggregate the actions of distinct groups (e.g. fuel reduction, land-use regulations, suppression agreements) across landscapes or ecosystems fragmented by a variety of landownerships [1,13,3]. For instance, one popular focus in both policy and fire science pushes for management of wildfire and associated natural resources at ecosystem scales in order to create fire-resilient landscapes. Fire resilient landscapes are those where fire plays a healthy disturbance role, that are less vulnerable to extreme wildfires which can irreparably damage ecosystem services (e.g. watershed functioning, wildlife habitat, etc.), and that can recover from wildfire events without significant human intervention. It also is widely acknowledged that what makes a fire resilient landscape can be context-dependent [16,62,88]. The makeup or "adaptedness" of human communities that operate as part of a fire resilient landscape have and will continue to influence landscape dynamics through choices about management strategies [71,74,12,98].

Wildfire social science research indicates that challenges or opportunities surrounding landscape-level fire management can stem from the social diversity of residents inhabiting lands where fire can be both a hazard and a natural disturbance force. Expanding development or subdivision of residential properties in areas interspersed with wildlands can introduce new human populations who have very different views or values for natural resources and wildfire management when compared to existing residents [21,75,77,79]. Likewise, existing residents' perspectives, skills and willingness to collaborate with neighbors surrounding wildfire can change over time and as broader social forces (e.g. economic opportunities, pressure for regulation, resource policy) influence the character of their interactions with local governments or land management agencies [49,100,102]. All this is important because the diversity of perspectives, values and capacities among populations living in fire-prone landscapes are likely to result in the development of differential barriers, foci and structure surrounding efforts to coordinate wildfire management at larger scales [68,70]. Despite these broad recognitions, much wildfire science and policy continues to suggest strategies for landscape-level fire management that are based predominantly on biophysical understandings, evidence or recommendations. That science acknowledges, but fails fully incorporate the ways that human actors might enable or constrain efforts to manage fire (e.g. use of prescribed fire, landscape-level fuel treatments, land use) through their continued interaction within and across landscapes [26,75,67].

The research presented in this article responds to the deficit described above by exploring the ways that interaction between residents,

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land managers, fire professionals, and government officials' influences local approaches to wildfire management. We use the term social dynamics in reference to the patterns, influences and perspectives characterizing the interaction between human actors surrounding wildfire management, including their influence on the scale at which management can occur. We conducted focus groups with a variety of professionals, residents, and government officials in a landscape spanning Idaho and Washington states of the U.S. Pacific Northwest to gain on-the-ground understandings of the ways that local social dynamics influence management strategies for wildfire. This includes exploring the extent to which variation in residents' values, skills, perspectives and relationships with the landscape leads to support or enactment of wildfire mitigation efforts. Results of our effort help illuminate tangible opportunities and barriers to collective wildfire management across landscapes and explore how social dynamics might influence progress toward creating fire resilient landscapes. In a broader sense, our efforts provide insight on the creation of "fire adapted communities" across diverse human populations and the ways site-specific social dynamics might influence their variable occurrence.

2. Literature review

2.1. "Scaling up" collective action surrounding wildfire

Existing policy and research have long recognized that one reason for the complexity of wildfire management is a need to reach across private ownerships and public lands managed by a variety of actors (e.g. agencies, county governments, residents) [60,97,12]. Fire management also can be complex because it is influenced by processes at various scales—from individual-level motivations about home construction materials or collective decisions about funding volunteer fire districts to regional or national-level policy about the allocation of resources to reduce hazardous fuels on public lands [1,20,43,48]. Issues of scale often play an important, but supporting role in research or policy discussions about fire. A variety of authors explore the "best" scale at which to manage or influence social (e.g. vegetation management on private properties), ecological (e.g. conflagration of fuel reduction treatments) and operational (e.g. fire suppression efforts) processes that are likely to impact future fire occurrence, behavior or impacts to human populations [115,16,3].

The thrust of much wildfire social science has focused on actions that different stakeholder groups can take to help more effectively manage wildfire on lands for which they have primary management control [24,57,25]. Each of these foci makes assumptions about the continuity or collective "buy-in" surrounding efforts that allow them to serve an aggregate function for wildfire management. For instance, a great deal of wildfire research focuses on behavioral intent or actual adoption of fuels reduction efforts and building practices that reduce potential wildfire risk to private property (see [109,13,22,78]). Research and policy focusing on private property mitigations often assume that there can (or will) be consistent adoption of such practices, and that they will alleviate burdens associated with fire suppression or preparedness (e.g. public lands fuel breaks). However, existing work suggests little uniformity in mitigation efforts among private property owners, or that performance of such mitigations prompts less state or federal expenditures for wildfire mitigation efforts on proximate public lands. Other segments of wildfire research explore the patterns or promotion of fuels reduction efforts designed to improve ecosystem health and/or reduce risk to nearby private properties (for example see [4,94,80]). Yet practice demonstrates that these projects may be differentially supported or blocked on the basis of incompatible views surrounding what is "natural" in the landscape, entrenched opposition among resource conservation or utilization groups, and the capacity of groups to work together [108,79].

The above examples demonstrate how actions taken by different actors—or supported by human populations on nearby public lands—may be incompatible, especially when considering human actors and their associated institutions (e.g. local governments) as part of the landscape [68,8]. As such, wildfire management now seeks to promote collaboration and cooperation across both private and public lands by facilitating a variety of actions that diverse populations can take to collectively manage wildfire for a variety of values [115,48,104].

It is only relatively recently that federal policy and approaches codified a primary focus on collaborations that cross ownerships as an effective means to better manage wildfire across larger landscapes [66,95,97]. Those efforts coincide with initiatives to "scale up" a variety of existing processes for managing the increasing suppression costs and risks posed to people by wildfire, including large-scale fuels reduction projects, comprehensive land-use planning, building standards or codes, and evacuation planning [104,4,80]. For instance, the "All Lands, All Hands" approach promoted by the U.S. Forest Service explicitly recognizes the need for collaboration and coordination across a variety of private landowners, local governments, and agency officials would be necessary to improve wildfire and ecosystem management at landscape-level scales [107,19]. Several existing or emerging programs help facilitate the "All Lands" approach, including the Collaborative Landscape Restoration Program, the Chiefs' Joint Landscape Restoration Partnership, and Good Neighbor Authority [111,112,64]. All these efforts provide different structures, objectives or mechanisms through which a variety of stakeholders can make collective planning decisions or implement coordinated actions that cross ownership lines. They frame the development and facilitation of such collective action as an important component in achieving landscape-level management—and something that will require compromise or tradeoffs among different values, benefits and goals of diverse human populations [6,81,94]. Accordingly, our next section outlines significant lessons surrounding collective action and the related concept of community.

2.2. Collective action and community

Lessons from existing research and practice indicate that collective action or cross-boundary effort requires stakeholder agreement about the parameters of management. This includes a shared view of "the problem," a willingness to work with other collaborators, and the development of partnerships that coordinate how each collaborator can best contribute actions or resources that help achieve management goals across the larger landscape [29,47,100]. Collective action surrounding wildfire also implicates the need for trust among parties operating at multiple scales, and a willingness to institutionalize actions, incentives or regulations that contribute to overarching goals [30,41,89].

A variety of theoretical concepts, methods, or frameworks are used to understand the contributors to collective action in the face of wildfire. Prominent examples include social capital, network analysis and the interactional approach to community (hereafter the interactional approach). Research using combinations of the above approaches often seek to incorporate notions of shared purpose, trust and cohesion among stakeholders by exploring the ways that local context or relationships help form bonds of "community" or interaction. Interaction among stakeholders, in turn, can help facilitate collective action that increases the overall well-being of stakeholders involved [55,82,96]. We review each of the above perspectives briefly in the following sections and then describe how they help frame our research questions for this work.

Social capital research focuses on the bonds between people, and how the accrual of good will, reciprocity and shared purpose among actors (i.e. capital) can help facilitate a willingness to act in ways that favor a broader set of actors [39,52]. Longitudinal studies of social capital in rural municipalities or regions documented a reduction in formal or informal opportunities for interaction among residents. The associated decrease or lack of social capital accrued in these areas led to a gradual decrease in collective or civic action in support of local community [37,83,87].

A number of wildfire related studies have operationalized social capital to explore its impact on support for mitigation actions or collective planning. Results suggest that elements of social capital can be influential in the proliferation and spread of wildfire mitigation actions performed on private property, a willingness to support collective wildfire planning efforts, and a desire to collaborate on collective fuels reduction programs [10,22,55]. The concept of social capital often includes explicit mention or exploration of networks, including the ways that new ideas proliferate or interactions occur between actors in a larger landscape [44,58,7]. For instance, researchers have explored networks associated with various land management agencies, local government officials and firefighting organizations to determine whether they promote cohesive or complimentary opportunities for collaboration among stakeholders that cross property lines. One conclusion from these efforts indicates that there can be very different approaches to interaction or proliferation of information across landowners depending on the makeup of groups operating across larger landscapes [33,40].

The interactional approach encompasses elements of social capital and networks by holistically conceiving of community as the product of interacting populations who organize on the basis of service-based dependencies, interest lines, or social and professional networks [114,105,71]. Community is treated as an emergent, process-based phenomenon that occurs when various actors who comprise different "social fields," choose to mobilize their unique resources, perspectives or skills in response to a disturbance, change, or shared issue that influences their functioning [106,36]. A social field typically refers to an unbounded nexus of interactions among actors organized by service-based dependencies, common interests, similar values for a landscape, or professional networks. The coming together or interaction between various social fields has the potential to create a "community field" [114,5]. The International approach places emphasis on community as a product of both routine and extraordinary choices by people who care about and share common meanings for a given place, who help create or perpetuate the services provided by their environment, and who have a history of ongoing relationships that structure their collective functioning [35,51,56].

A series of papers has extended the interactional approach to wildfire management by characterizing: (1) differential relationships among residents (e.g. the structure of communication networks in an area; presence of local champions, and risk reduction initiatives among agencies and locals, etc.); (2) access to and ability to adapt scientific or technical knowledge networks (e.g. community organizations or collaborative, diversity of people or skills in a locality, etc.); (3) place-based knowledge and experience (e.g. local peoples' experience with wildfire, local ability to perform mitigation action, etc.); and (4) demographic or structural characteristics (e.g. development patterns/landscape fragmentation, number of second or seasonal homeowners, etc.) [77,74,42]. Paveglio et al. [76,72,68] nest 21 specific characteristics within each of the above conceptual realms (examples provided in the immediately preceding list) to suggest that the interaction between such characteristics in a locality can help explain the emergence of communities across a landscape and differential strategies for collectively managing wildfire. Subsequent research using the interactional approach uncovered patterns of local social context that help demarcate a continuum of "archetype communities," each of which is likely to feature unique opportunities, constraints and support for existing or emergent strategies to manage wildfire risk [73,74]. That is, distinct communities operating in the same landscape may support or enact different policies, programs or strategies for co-management across ownerships, and their given "path" for fire adaptation may look very different due to variance in the values that characterize their community [68,70,96].

There are far fewer research studies that explore the variable development of community or potential for collective action across larger landscapes. That appears to be a conspicuous absence when considering the widespread recognition that a variety of processes continue to restructure social dynamics across wildfire-prone regions of the U.S. West (see [46,2,45] for discussions). For instance, many authors have long discussed how amenity migration or the associated expansion of residential settlement near wildlands can lead to "culture clash" between new and existing residents concerning natural resource extraction, active management or resource preservation, and the importance of outdoor recreation opportunities [110,50,93]. Similarly, wildfire researchers have noted how the turnover or settlement of wildfire-prone areas by new residents and second homeowners may mean they bring with them expectations about fire services, regulations or personal freedoms related to wildfire. It can also mean that newcomers bring very different experiences or awareness of how to collectively manage wildfire hazard [17,28,77]. More broadly, the aforementioned research is a good reminder that social systems can be just as, if not more dynamic than the biophysical conditions that research and policy often cite when prescribing the "best" scale at which to manage wildfire. The values and related relationships people form with their environment can shift between or within generations, and may influence the tradeoffs each population weighs when thinking about the risks or benefits of collectively managing risk [27,54,99].

In summary, existing wildfire research has frequently focused on seeking out and explaining cases of successful collective action. This often entails selection and study of discrete "communities," operationalized variably as emergent units, city boundaries or other jurisdictional units (e.g. fire districts, homeowners associations, forest districts, neighborhoods, etc.) (see [59,100,68]). There also have been efforts to compare populations in different regions or states (see [44,108,74]). Yet it is important to remember that the lack of community, or the conflagration of diverse communities in a given place, can serve as an important influence or barrier on efforts to promote landscape-level actions [14,29,82]. It requires thinking about and gauging the level of "social fragmentation" that may be present across a landscape where stakeholders are hoping to promote fire-resilient landscapes, and thus a more emergent conception of community that is dictated by local action, and not just by pre-defined administrative or policy units. By social fragmentation we mean the variable nature of human values, perspectives, skills, and relationships with the landscape that influence the occurrence, size, and characteristics of communities in a landscape [68,91]. The nature of social fragmentation and associated social dynamics in a given place is likely to influence the process of co-management across ownerships, and thus is a critical influence to account for in future management. This study seeks to expand research surrounding wildfire adaptation by exploring the way that local social dynamics have and will continue to influence collective management of wildfire among stakeholders. We ask the following research questions to that end:

1. How do social dynamics affect the scale at which management of wildfire occurs?
2. How do emergent communities or social fragmentation affect collective fire management?

3. Material and methods

3.1. Site selection and data collection

Researchers began the process of site selection by searching for adjacent fire-prone counties that were each likely to contain a range of diverse human communities. We gauged community diversity as the presence of multiple "community archetypes" articulated by Paveglio et al. [74,68]. Counties containing multiple "community archetypes" are more likely to be socially diverse, and thus more likely to feature social dynamics that may be in a state of flux. This includes factors such as amenity migration, changing settlement patterns, differing perspectives about public land management, and place-based knowledge. Our interest in neighboring counties came from a need to understand whether and how the social diversity that may be operating in each county might influence wildfire management approaches across adjacent units of management. Therefore we did not set out to treat each county as a comparable case study, but instead sought to understand how and whether social dynamics were influencing wildfire actions across a larger region.

Bonner County, Idaho, and Pend Oreille County, Washington, were selected as potential sites for study because of continued amenity migration and recreational properties in both locations, long histories of working timber and agricultural lands, and the high proportion of public lands used for recreation or resource extraction. Both counties were impacted by the Kaniksu Complex fires in 2015, a conflagration of seven lighting ignited wildfires that burned approximately 26,124 acres and incurred more than $26.3 million in suppression costs [65]. Finally, researchers contacted select key informants with comprehensive knowledge of each location (e.g. emergency managers, university extension agents) to discuss and confirm social diversity occurring within counties. Key informants in each location provided initial suggestions and contacts for focus group sampling and helped researchers ensure that each location would provide data relevant to our research questions. They later served as focus group participants.

Focus groups are ideally suited for obtaining information about broader populations from a subset of highly knowledgeable informants. The discussion-based format of focus groups allows researchers to elicit rich description of local social dynamics and to observe how interaction between participants leads to common outcomes or meanings surrounding a topic [15,32]. The authors facilitated a total of five focus groups as part of this research. At least three authors were present at each focus group, and the primary author served as the lead facilitator for all focus groups. Three focus groups took place in Pend Oreille County and two focus groups took place in Bonner County. All focus groups took place during the late summer and fall of 2015. Focus group discussions each lasted between approximately 90–120 min and were recorded with the permission of participants. Each recording was transcribed word-for-word for later analysis.

A total of 43 individuals served as participants in the focus groups. This included 24 participants from Pend Oreille County and 19 participants in Bonner County. Researchers used a combination of theoretical and snowball sampling to recruit participants for data collection. Theoretical sampling includes selecting a diverse cross-section of respondents who have specialized knowledge of the topic in question [18,53]. Snowball sampling (or chain referral sampling) complements theoretical sampling by having initial respondents suggest additional contacts who could more fully represent the diversity of perspectives in each study site or provide additional insight concerning our research questions [90,9]. Theoretical sampling for this research meant identifying a broad set of individuals who had experience interacting with a broad cross-section of stakeholders surrounding fire management or response. Categories of respondents contacted from each county to participate or suggested by contacts included local fire district officials, state fire managers or outreach specialists, federal fire managers or outreach specialists, county planning and zoning officials, county commissioners, emergency managers, local residents actively involved in fire planning, timber industry officials or area ranchers, and representatives of local utility companies. Recruitment was only stopped when researchers and respondents felt that the addition of new contacts would fail to provide additional perspectives, which is sometimes referred to as “theoretical saturation” [15,63].

Researchers designed a semi-structured focus group protocol to guide discussions between participants. That semi-structured interview protocol began with questions about what was most at risk from wildfire in each county, specific populations who may be at higher risk than others from wildfire, the reasons for higher exposure to risk among some populations, and what general approaches had been taken to reduce risk in each area. Successive blocks of questions asked about the feasibility, influences on and local performance of wildfire management approaches at a variety of scales often discussed in existing policy or research.

Broad topics covered in later sections of the focus group protocol included: (1) voluntary or required fuel reduction efforts near structures on private properties, fire-resistant retrofitting or new construction standards, and insurance incentives or additional taxes to fund fire response; (2) homeowner association requirements for wildfire planning, planning and zoning efforts to reduce residential exposure to wildfire risk, and collective programs (e.g. Firewise Communities USA program) designed to improve wildfire adaptation; (3) the most effective strategies for managing public lands and associated fuel loads in each county, including tradeoffs between fuel breaks, commercial harvest, stewardship contracting, prescribed fire and assessments of regional capacity to generate revenue from fuel reduction; (4) prioritization of values-at-risk during fire response, relationships between residents and firefighters from different organizations (e.g. local districts, agencies, outside firefighters), and planning for evacuation or alternatives to evacuation; (5) pressing needs for recovery following wildfire events, organization of aid efforts and potential restoration needs following fires; and (6) effective messaging to diverse stakeholders concerning collective wildfire management.

3.2. Analysis

Data analysis for this effort occurred in two phases. The second phase of the analysis utilized the qualitative coding software QSR NVivo 10. Researchers present at each focus group debriefed following every meeting to discuss major emergent ideas or themes present in participants’ descriptions of wildfire management approaches and their associated influences. They also discussed any lingering questions, contradictions or additional questions that may confirm or reject emergent themes in subsequent focus group [90,101]. Initial theme development allowed the authors to ensure that consistent themes were emerging from the data, that no additional data collection was needed (i.e. theoretical saturation), and that authors could ensure consistent interpretations of participant responses.

The second phase of data analysis employed processes of analytic induction and thematic analyses to refine and substantiate emergent themes from phase one or uncover additional insights. Analytic induction provides a systematic process for uncovering and evaluating underlying meanings in participants’ knowledge surrounding a particular topic of interest [85]. Thematic analysis provides a complementary coding process for analytic induction by identifying commonalities in respondent experience, knowledge or perspectives [11,38]. Researchers used both processes to develop a multiple-stage process of increasingly restrictive coding to uncover, articulate and affirm emergent themes by evaluating their occurrence across the data. Each stage of the coding processes occurred separately, and entailed a separate review of the data. More specifically, the coding stages conducted included: (1) “topic coding” to label the broad topics discussed by participants; (2) “pattern coding” that segmented results of topic coding across study locations (i.e. each county) for comparisons and; (3) “analytic coding” that articulated consistent connections or relationships between topics, the meanings associated with those topics, any relation to initial themes from the field, and relationships to our research questions (see [84,38,86] for details on each coding stage). A final round of analytic coding refined the connections between emerging themes, helped situate specific examples beneath overarching ideas, and organized themes within a larger narrative (i.e. the subsections of our results presented below).

The lead researcher reengaged two other authors following the final round of analytic coding to present results from the other coding stages. The two additional authors reviewed each stage of the coding process independent of the lead author to confirm consistency in the outcomes of each coding stage. Finally, the authors selected a few of the most representative quotations for each theme and subtheme in order to best represent key findings.

4. Results

4.1. Social fragmentation and wildfire management

Focus group participants in both Pend Oreille and Bonner counties indicated that the diversity of residents living in their respective areas heavily influenced the ways they could approach wildfire management. They indicated that a lack of familiarity and cohesion among landowners living in portions of each county meant that collective efforts to promote fuels reduction projects, evacuation planning or support for public lands management were difficult to achieve. Participants also described how the scale of potential mitigation or management efforts occurring in any area would largely be dictated by who was willing to work together or with public lands managers. For instance, one participant from Pend Oreille described mitigation efforts for a portion of the county this way:

> It's going to have to be the home level because so many of our communities and our neighborhoods are so diverse, the population and who's year round versus who's here seasonally versus who's a farmer. It would be really hard to come in here and try to get a whole community or whole neighborhood to say, 'Let's do this.' "

The variable scale of interaction among landowners and between private landowners and public land managers contributed to a mosaic pattern of populations who may have very different capacities to organize, introduce, or enforce planning efforts. As one participant from Bonner County described: "It's a hodge-podge out there. You could have a guy that's been living there a hundred years who's Billy Bob living next to Billy Bob, then you got people who come from California with a billion dollars on their ranch."

Focus group participants indicted that land managers and local government officials in both counties favored a wildfire management strategy centered on actively reducing the buildup of fuels in forests across the region. However, they also outlined how the social fragmentation of human populations described above could serve as an important impediment to establishing landscape-scale fuel reduction projects. The variety of landowners who might contribute to or benefit from fuel reduction projects could not always agree upon the goals or outcomes of proposed forest management. Likewise, participants described increasing success in the promotion of private property mitigations and cost share programs among individual property owners in both counties, but admitted that these efforts were not always consistent across adjacent or neighboring properties. The result was piecemeal or fragmented fire management efforts that might not be as useful in achieving landscape-scale outcomes. As one participant from Pend Oreille County described:

> We haven't really had much in the way of fuel break. It's something, a strategy that we just kind of discarded at the beginning because we're so scattered around here, that it's almost got to be individual actions rather than … We want to get communities to work together.

Participants described historic conflicts surrounding "appropriate" management of forested public lands as one enduring legacy of social fragmentation in the region. While some populations favored active management or harvest to reduce wildfire risk and support the local forest products industry, others favored forest restoration efforts, less intensive management of public lands or management focused primarily on enhancing opportunities for outdoor recreation. As one participant from Bonner County described:

> We've got a dichotomy of those who want to just go out and enjoy the forest. What we call the environmentalists, the conservationists, etc., which is a huge community here. We also have those in the timber industry. Those who have made their livelihood and traditionally their families off of either being loggers, or the timber mills, the truckers. That's a huge community as well, but has been steadily decreasing. We get hit with it all the time from both sides, because we have to represent all of them.

Historical conflict about public lands management correlated with what focus group participants described as a slow decrease in local capacity (e.g. timber industry professionals, mills) to reduce fuels. It also corresponded with an increase in residents who may be reluctant to reduce wildland fuels because it might affect the "naturalness" of the area or reduce the aesthetic amenities (e.g. privacy, wildlife habitat) that brought them to the area. A participant from Pend Oreille County described one example:

> Down on the first road I came to a beautiful home. Trees right up against it all the way around. Tall, beautiful trees. That's not abnormal for that community because they want to be in that natural environment. So they don't want to cut anything more than they absolutely have to for their need, and when the wind blows it over, that's the time you cut it up.

Though participants acknowledged that social dynamics and associated patterns of landownership could influence multiple facets of wildfire or land management, they stressed how understanding the roots behind such fragmentation was key to promoting any collective action. Actions to reduce wildfire risk and promote landscape-level management would need to consider the unique circumstances of various stakeholders who had created smaller communities or "micro-habitats" across the landscape. As one participant from Bonner County summarized:

> How to get that education out to where it's actually meaningful, where it makes an impact on the land itself. That's a difficult thing, because the motivation is really difficult with each group, and what motivates them. Some of it is timber, managing your place for timber, others it's aesthetic.

4.2. Getting to the heart of social fragmentation

Focus group participants in both Bonner and Pend Oreille counties described the ongoing evolution of landownership in both regions as a primary source of the social fragmentation influencing wildfire management. For instance, amenity migration in both regions introduced residents with different views about use of the landscape, fewer opportunities to engage with other residents—and in some cases—less interest in engaging with people already living there. Portions of both counties have observed large increases in tourism related to outdoor recreation (e.g. hunting, boating, hiking, etc.). These changes could result in additional challenges associated with evacuation, and additional values-at-risk to consider when planning for wildfire management disruptions (e.g. smoke exposure, road closures). As one Bonner county participant described:

> The population around the lake (Priest Lake) is 800, but then weekends, it's 35,000. We have to approach how we evacuate, how we look at public safety … Especially if we have to evacuate, but then we have businesses that want to make money and continue to operate.

Focus group participants described how continued trends of amenity migration in both Bonner and Pend Oreille counties had led to "waves" of new recreational properties, second homeownership or absentee forest landowners. They paid particular attention to the way some properties in Pend Oreille County had become weekend recreational cabins or "bedroom communities" for those driving to work in larger metropolitan areas such as Spokane. Amenity migration was particularly prevalent near the many lakes in both counties, and surrounding Schweitzer Mountain Resort (a ski area) near the city of Sandpoint. Development patterns in these areas might range dramatically across units and even among neighbors—from small recreational cabins to large and opulent homes on larger lots—the conflagration of which posed various challenges for fire management. For instance, one Pend Oreille participant described the following challenge associated with managing fire risk in dense development near a recreational lake:

> You don't have a lot of flexibility of what you can do when your houses are six feet apart and they have traditional wood siding. They have composition roof that is not fire retardant at all, they've got the class C ordinary roof covering scale. They're cottages that don't necessarily have year-round residents in them.

Conversely, participants described how other portions of Bonner or Pend Oreille counties faced very different challenges. In those areas, a strong desire for property rights and independence led to challenges in mobilizing any collective action—or even having a comprehensive understanding of values-at-risk from wildfire. As one Bonner County participant described:

> You talk about the people who have moved in up on the skid road, the improved skid road, 40 miles up in there. A lot of those folks are just trying to escape an asphalt jungle someplace. By that nature they cut that little square, and I want my house here, and I want to be left away from everyone else…They came from another place, they don't really fully understand the culture, the fire progression. Plus, they want it to be just as shady and close and tight as they possibly can. You have bad access, you have a lot of fuels, you have no knowledge. That's a bad combination.

Although participants described variable patterns of populations and communities across their shared landscape, they did settle on broad categories that represented the range of socially diverse populations operating in both counties. For instance, participants described farmers and ranchers operating in portions of Pend Oreille County as "communities" with distinct views and values that might not resonate with prominent fire mitigation outreach programs focusing on fuel reduction around homes. However, participants also indicated that farmers and ranchers may have some means and equipment to help suppress wildfire on their private property, or provide assistance to professional firefighters in the area. As one Pend Oreille county participant explained:

> If you look at this area as far as small timberland owners, it's the largest number this side of the Mississippi…They're doing those forest management projects beforehand plus maybe around their house. But it (Firewise) is not a thought for them.

Participants in both counties described individuals associated with or with multi-generational ties to the timber industry as a population who supported active fuels reduction. They indicated that individuals associated with such "working landscapes" had a good understanding of fire as a recurrent component of the landscape. They might be more willing to see fuels reduction projects extend across ownerships. As one Bonner County participant described: "It's not as large as it used to be, but the folks that are employed in the timber industry, they understand. They know the risks associated with fire."

Additional communities described by participants were partially introduced above. They included rural "off-the-gridders" who often interacted only locally among neighboring properties and who were often hesitant to interact with government authorities, and "lake retirees" or recreational property owners who moved to the area for outdoor amenities but who may not have the skills, resources, ability or interest to contribute to wildfire mitigation. One participant from Pend Oreille County described some of the challenges associated with select "off-the-gridders" as such:

> I can tell you right now even with the building codes and stuff that we have, within a half hour I can probably take you to a half dozen places that are two chicken coops nailed together, and we've got a whole family living in them. It's just that bad, and it's things that the departments would be interested in going out to, but some of it is lifestyle choice… It doesn't matter what you tell them. If it doesn't fit into their plan, they don't care and they're not going to comply.

4.3. Adapting to social fragmentation

Focus group participants in both locations eventually concluded that the scale of wildfire management efforts would primarily be dictated by the cohesiveness of human populations whose actions and interactions were an important influence on the larger landscape. They stressed working at the scale of "community" –or smaller "clusters" of residents and landowners who could collaborate with land management agencies or local government officials as a relatively cohesive unit. However, participants also indicated that "communities" may not exist in some areas, or no longer be geographically contiguous due to social fragmentation. As one Bonner County participant described:

> You see it (wildfire adaptation) in little isolated pockets where a neighborhood just ... There isn't any sort of neighborhood association or anything, but you do see that one person takes some pride in something and cleans up their property. That seems to spread.

Developing "community" was one key focus participants described as a means to implement larger wildfire management initiatives. For instance, participants discussed how an initial focus on reducing risk to private properties or specific values-at-risk (e.g. merchantable timber, popular recreation areas) could allow opportunities for a broader focus on landscape-level actions. Yet getting to that point required leveraging existing interactions, commonalities or shared values among socially fragmented or isolated populations. Participants described variable mechanisms for building "community," that might facilitate fire adaptation, including collaboration with homeowners' associations where they were present, engaging rancher associations or tribal bodies, and working across kinship or family groups. As one Pend Oreille County participant described: "Those new homeowners out there, if you get a homeowners' association you can talk to those. Those are the areas that you might get it established. Some of these older homes that are established, probably less likely."

One overarching conclusion stressed by focus group participants was a need to plan and adapt different fire management efforts in response to the patterns of community or fragmentation across landscapes. That meant recognizing how different messages, strategies and programs might be more effective for engendering the support needed to carry out management actions or encourage landowners to partner with other stakeholders to address wildfire risk. Some participants described concerns about quick and effective evacuation in dense developments near lakes. In other locations it was well known that landowners would likely remain at their property to fight fires or be willing to donate equipment for active wildfire suppression—provided they had already worked with appropriate agencies to register that equipment. Likewise, residents described how efforts to manage forest landscapes in the area may need to incorporate different prescriptions or be implemented under different authorities in order to allow for collaboration across the diverse range of interests. For instance, one Bonner County participant described collaboration surrounding fuels reduction treatments on federal and private lands as such:

> Where I'm leading with that is there's some phrasiology with that. The stewardship program, it's an easier program for the preservationist public to swallow and they are good programs, they have many more facets to them. Well, we're going to build some trails along with harvesting the unit, but we're talking about the same

thing, both the timber sale and the stewardship program and that is addressment of wood fiber, and the loadings thereof.

Participants also described how regulations relating to private development, including building codes and landowner vegetation mitigations would not be well supported or enacted by residents in many of the rural locations throughout both counties. However, they did indicate that such actions may be more useful and acceptable in dense developments near lakes or in areas that continued to be developed for residential or recreational properties. The following dialogue between in Pend Oreille County participants illustrates these points:

Participant 1: Enforcement would be dangerous. To the point that there are a significant portion of the population in the county, that telling them to do something on their property, that person might not return back to his-
Participant 2: There would be guns involved.

One place where participants indicated that progress was being made across landownerships and perspectives concerned broader timber management strategies on public and private lands in the region. Participants described how the development of forest collaboratives or forestry coalitions in both North Idaho and Northeastern Washington allowed multiple stakeholder groups—often with different perspectives about ecosystem management goals—to better understand their varied perspectives and find common ground to advance fuels reduction projects. The result had been a reduction in litigation or conflict that had traditionally restricted management action. As one Bonner County participant described:

We've got root rot, we've got disease, we've got sedimentation in our water streams, that kind of thing. We get together, we fill out and we discuss these things, and we come to a collective decision on it. Those things seem to be working. Expanding the timber harvest, but the manner in which it is harvested is sculpted, shaped so it's not a clear cut block that a lot of people object to. There's ways of adjusting and managing.

Increased opportunity or support for landscape-level treatment projects might not always translate immediately to action, however. Participants described how the historic loss of local timber mill capacity, including facilities, markets and trained forestry professionals could eventually become a limiting factor in conducting all the work necessary throughout both study counties. The social and parcel fragmentation occurring on private lands also meant an increased need for small-scale contractors who could work with individual properties and the associated timber market for small-diameter wood. As one Pend Oreille County participant outlined:

We've lost so many of the saw mills, and many of the crews that used to do things. We've actually had to … we got a lone crew who is doing a bunch of the Firewise stuff this year. Sometimes we've had to go to Colville in order to do that.

5. Discussion

What does it mean to be a good fire neighbor? When you are individuals living next to individuals. Private property. What does it mean to be a good neighbor to citizens around you? And then for the public lands that are adjacent to those? What is their responsibility to you? That is what is missing. –Bonner County participant

The purpose of this research was to better understand how place-based social dynamics influence the scale and capacity of wildfire management approaches across landscapes. We engaged a variety of emergency professionals, local officials, residents and firefighters who could speak to social dynamics operating across two adjoining counties to uncover on-the-ground experiences surrounding wildfire adaptation efforts. We also engaged those focus group participants in a discussion about the strategies and scale of management that will be necessary to forge collective action surrounding wildfire management.

Our results suggest that social fragmentation and the development of distinct "communities" operating across landscapes can restrict or enable collective efforts to promote wildfire management at landscape scales. These variable social dynamics are the result of historic and ongoing patterns of settlement and upheaval in the landscape—they stem from the varying perspectives, values and person-environment relationships held by landowners who settle into distinct "clusters" or are interspersed across fire-prone ecosystems [76,98,12]. Our respondents indicated that addressing cross-boundary management of wildfire in this setting meant: (1) recognizing patterns of social dynamics across the landscape; (2) tailoring activities, incentives and ideas to distinct communities where they exist; and (3) building a common sense of purpose or shared values to create "community" where interaction among stakeholders may be lacking.

Our results also reaffirm how area social dynamics can heavily influence broader processes surrounding ecosystem or forest management on public lands where fire plays a natural role [49,8,102]. Disagreements and later compromises about forest management actions in our study area required trust building and identification of common goals among diverse stakeholders surrounding the ways that proposed management actions would impact different values-at-risk in the area. It also meant assessing trade-offs between the outcomes of various wildfire management strategies. We expand upon each of these points in the following sections, and discuss how our results corroborate or extend existing research on the subject.

5.1. Social fragmentation and fire resilient landscapes

Our results intersect with the ongoing dialogue about the "best" scale at which to manage wildfire by illustrating how historic, ongoing or emerging social dynamics might limit or enable landscape-level management efforts. For instance, our participants quickly acknowledged how human populations living across each study county could vary drastically in terms of their values for or uses of the landscape, perspectives about active forest management and willingness to engage with neighbors in their locality (see also [14,100]). The granularity and pattern of those differences—that is the extent to which social diversity occurred across adjacent landowners, broader "communities," or in irregular spatial patterns across landownerships—could influence larger wildfire management efforts by dictating the consistent or variable proliferation of specific mitigation activities, planning efforts and support for resource management across the landscape. Our findings match emerging insights that wildfire is inherently a collective problem, and that addressing human populations' variable relationship with their landscape may be an important vehicle by which to design place-based solutions (see [77,74,73,69]). The work presented in this article advances those perspectives by indicating how social fragmentation or social diversity can occur at small scales across neighboring human populations in the same landscape.

Waves of amenity migration, reduction in resource extraction capacity (i.e. timber industry), and expanding residential development in both our study areas had led to an influx of residents who may not interact regularly. Participants described the proliferation of diverse populations who were driven by different motivations and values, or who had different skills and capacities by which to work together across their common interests (see also [21] or [82]). As a result, many of our focus group participants indicated that their efforts to address wildfire risk or management needed to occur first at smaller scales (e.g. the household, neighborhoods)—because this is the scale at which collective action was currently possible. Social fragmentation also was one important reason for historic conflict over resource management associated with wildfire risk. This shares much in common with existing research on the changing social dynamics of western U.S. communities transitioning from economic sectors dominated by resource extraction to ones that focus on tourism or amenity migration [2,46,54]. Likewise, our results parallel and extend notions of "culture clash" surrounding forest management associated with wildfire risk, as shifting social dynamics may change the nature of collaborations, priorities or processes that are needed to manage shared resources [110,93]. The outcome of our observations should not be misconstrued as blame toward either longer-term working landscapes or newer amenity populations in our study region. The U.S. West has long been a place of characterized by waves of social change, and that process is unlikely to subside anytime soon. Working landscapes will continue to proliferate across the area, and amenity values may shift in the future. Rather, our point is that changing social dynamics will continue to affect wildfire management—policy, programs and practice should both anticipate and address the way those dynamic changes influence what is possible in terms of landscape management.

Building capacity to address wildfire management across ownerships in our study area meant forging connections, shared values, and trust across populations to promote "contagion" effects that build up over time. It places a focus on the development of shared norms and values that promote a "community field" or social capital that can facilitate sustainable collective action [114,37,51]. At the root of these issues was the variable need to foster more interaction among diverse stakeholders operating in the landscape, whether that be existing cohesive "communities" or neighboring individuals who may not have as much opportunity to form the bonds that underlie community.

Fostering "contagion effects" is a common theme across the wildfire social science or hazard literatures (see [109,13,57]), but it requires a more explicit focus on the absence of conditions leading to collective action and community. Put another way, our results suggest that social fragmentation, and thus a greater potential for lack of community, also is an important aspect for researchers and managers to study or acknowledge given that fire is a collective problem requiring coordinated actions across ownerships. It implies a need to better gauge how "communities" form—or do not form—across landownerships and the combination of local context factors that enable or constrain the development of a "community field" that prompts stakeholders to marshal shared resources toward common goals (see [36,51]).

Important points related to these findings are that social diversity might not always lead to the negative aspects of social fragmentation, and that high levels of homogeneity among residents have the capacity to make such populations incapable of adapting to change. Thus, social fragmentation and social cohesion cannot simply be thought of as binary conclusions that always lead to bad (social fragmentation) and better (social cohesion) outcomes. Regarding the first point, existing research and theory indicate how the development of community includes the use of diverse skills and knowledge among members that help them achieve broader goals [114,44,41]. Such social diversity can be a strength when it interacts with other elements of local social context that help build community (e.g. shared communication networks, community identity, etc) and when the expression of those social context characteristics (e.g. residents capable and willing to lend their fuels mitigation equipment or expertise to other landowners) help facilitate productive mitigation. Conversely, homogeneity in skills, values, perspectives, or resources among landowners that are not applicable for reducing wildfire risk or that serve as barriers to mitigation actions (e.g. pervasive poverty, distrust of government, lack of knowledge about the role of fire in the landscape) may make them less capable of adaptation [68,74]. The complexity of these expressions in social diversity across the landscape, and their population specific patterns, is one reason why later portions of this discussion advocate for processes and methods that help document or consider the impact that site-specific social dynamics may have on efforts to promote landscape-level management of fire.

The majority of wildfire social science has focused on explaining cases of successful action in an attempt to re-engineer those conditions elsewhere. It focuses far less on dynamics operating across distinct populations operating in the same landscape, or on the failures of these populations to promote coordinated, yet distinct actions that serve broader landscape purposes. Likewise, survey or panel methodologies used to gauge the performance or intention to support adaptive wildfire action often lack the response coverage or range of adaptive actions that would be necessary to fully capture the potential diversity of landowners operating in a landscape. They may conclude that there is a "one-size-fits all" solution by gauging whether populations are performing or supporting the actions *researchers or high-level policymakers* think are most indicative of fire adapted communities, despite widespread evidence that diverse populations conceive of those goals very differently (see [77,76,12]).

Social fragmentation can create tension with overarching calls to promote landscape-level management (e.g. All Lands) or biophysical efforts to model the scale at which people should manage wildfire and associated resource conditions. For instance, one dominant thread of ongoing research and policy surrounding wildfire suggests that there often can be a "scale mismatch" between human planning surrounding wildfire management and the scale at which it should be managed across a landscape [3,4]. That is, human populations' planning or efforts to address wildfire should "scale up" to reflect biophysical science indicating a larger geographic footprint of potential fire transmission and historic or current fire regimes that will best promote "healthy" landscapes or reduce risk of losses (see also [95,94,104]). The practical reality of management approaches seeking to utilize those arguments is that they carry the risk of being technocratic—they might not well account for various landowner perspectives about what makes a "healthy" landscape or what they have at risk. They are unlikely to resonate with or achieve collective action if they do not reflect the reality of private property rights or public property responsibilities in a given area. Instead, arguments about "scale mismatches" that fail to seek out and incorporate local social dynamics may help create and perpetuate a "knowledge deficit" model of science by which researchers attempt to "educate" and evaluate increased awareness among residential, government or managerial populations using the one-size-fits-all approaches described above [23,61].

Avoiding technocratic approaches to landscape-level fire management means developing processes or data collection efforts designed to gauge local social context (including social fragmentation) development of community, and the existing potential for collective action at various scales. It also means finding ways to better incorporate local perspectives and context early into any decision-making process. Both of these efforts are more likely to enable the trust, support and interaction necessary to create "contagion effects" across landownerships and foster community among even diverse interests.

In light of the above omissions we feel it is important to call for additional consideration of social fragmentation as an important influence on wildfire management and associated discussions about practical, place-based advances in wildfire adaptation. People and landscapes grappling with the legacy of historic or ongoing amenity migration, rapid turnover of residents, or inhabitants developing differing uses for natural resources may in fact have a *community development* problem that interacts with ongoing trends in increasing wildfire risk. Ignoring historic and ongoing patterns of social fragmentation, cohesion and influencing social dynamics means failure to recognize one important reason that scientific research does not consistently translate to action in a real-world setting.

Studying social fragmentation is a difficult endeavor because it means focusing on the absence of action or interaction. Tangible indicators or outcomes of social fragmentation might include spatial patterns of variance in parcel sizes, property use (e.g. residential vs. farming), turnover rate or seasonal vs. full-time use. It could also intersect with biophysical or remote sensing approaches looking at the fragmentation of vegetation, wildlife habitat or plant associations across a landscape. All of these indicators have been used in existing research to explore wildfire management support, mitigation action or wildfire vulnerability. However, the above indicators alone do not necessarily paint a full picture of the ways social dynamics can influence wildfire management—and often drive contemporary patterns in landscape fragmentation.

While secondary data is effective, a large body of literature has long argued that primary data collection, including self-assessments of local capacity, place-based knowledge and experience, or social capital serve a critical role. Our results continue to demonstrate how studying community or its absence means a more comprehensive, qualitative understanding of local perspectives, histories and interactions among populations. It focuses on who people are, why they live in a place, and how relationships among populations and with the landscape contribute to larger concepts of well-being or sustainability [43,44,74,75,96]. Primary data also allows researchers to explore the ways that elements of local social context, including social diversity, homogeneity, and cohesion combine to influence variable scales of adaptation or collective action across the landscape. Understanding the deeper reasons behind such action provides avenues for tailored action that can help build community and shared, but variable responsibility among landowners or land managers with different abilities or constraints on their mitigation actions.

In-depth data collection is an integral component of the interactional approach to community, which treats community as an emergent property that is constantly created and recreated by interaction among inhabitants of a given place [114,36,56]. Ongoing work using the interactional approach stresses the systematic documentation of both quantitative and qualitative indicators related to a range of characteristics associated with broad "realms" of local context (e.g. place-based knowledge and experience, demographic and structural characteristics, etc.). Each indicator would allow diverse stakeholders the opportunity to consider and select from range of descriptions matching variable expression of local characteristics (e.g. sense of community or belonging) or provide quantitative scales to help collect measurable data about influences on local action (e.g. average parcel size and standard deviation, proximity to mill facilities). The interaction and intersection of these various characteristics—how their combinations enable or constrain action—provide a more holistic and action-oriented means to plan future collective action by developing combinations of programs, policies or incentives that best respond to those conditions [72,68]. Outcomes of data collection related to the interactional approach and indicator approaches for social fragmentation could eventually be compared with existing quantitative benchmarks for performance of wildfire mitigation planning and response. Examples include: (1) the number, proportion or spatial continuity of fuel reduction efforts performed by private landowners; (2) the establishment of cross-boundary partnerships; (3) acres of restored wildlife habitat, the presence or number of recognized Firewise communities; (4) damages avoided from fires, and others. The relationships between efforts to better understand local social dynamics and these existing metrics can help explain whether fire management approaches succeed or fail. They also can serve as a basis to design more flexible programs that might apply variably to different landscapes containing diverse communities or patterns of social fragmentation.

It is important to note that both our results and previous research suggest that the completion of systematic assessments for gauging local social dynamics should consider community as an emergent property, and not one that is dictated solely by existing political or geographic boundaries. It implies that a place-based representation of community or social fragmentation is likely necessary across landscapes, while also acknowledging that a perfectly accurate depiction of community is not always contiguous or complete [114,71]. Completion of assessments conducted across larger regions using the interactive approach could potentially yield a more comprehensive picture of the social dynamics operating in any given landscape. These dynamics could be It also has the capacity to better understand what shared values, perspectives or messages can be used as a starting point to expand the boundaries of "community" through co-management efforts that promote contagion effects across diverse human populations.

6. Conclusion

Wildfire science acknowledges, but often struggles to address community functioning or the occurrence of social fragmentation as important contributors to ongoing discussions surrounding wildfire management. People and their influence on management possibilities are pervasive across landscapes where fire plays an important, but increasingly uncertain role. Ongoing trends and patterns in human development are one important indicator of social diversity—but they are only echoes of deeper dynamics surrounding variable human perspectives, values, ways of knowing, and interactions with the landscape that add considerable complexity to the development of collective management approaches. Our results suggest that there may not be one "best" scale at which to manage wildfire, and that diverse stakeholders grappling with what it means to "live with fire" understand how social dynamics can dictate the range or scope of efforts to address wildfire at landscape scales. Instead, it is important that research, policy and ongoing monitoring surrounding the creation of fire adapted communities recognize that making progress on fire management may mean working at the scale that is currently *possible* among landowners who are all part of a landscape. It also means designing mechanisms that can help determine where social fragmentation might make adaptation more difficult, and how that translates into different strategies or timelines for achieving measurable benchmarks toward the goal of creating fire adapted communities.

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Declaration of interest

None.

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