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social sciences

Incorporating Social Diversity into Wildfire Management: Proposing "Pathways" for Fire Adaptation

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Existing research suggests that adoption or development of various wildfire management strategies may differ across communities. However, there have been few attempts to design diverse strategies for local populations to better "live with fire." This article extends an existing approach by articulating how characteristic patterns of local social context might be used to generate a range of fire adaptation "pathways" that can be applied variably across communities. Each 'pathway' would specify a distinct combination of actions, potential policies and incentives that best reflect the social dynamics, ecological stressors, and accepted institutional functions that people in diverse communities are likely to enact. We synthesize existing research to propose broad considerations that would form the basis for diverse pathways. We then use existing research and the aforementioned considerations to propose specific components of pathways for two example community 'archetypes.' We contend that advancement of the conceptual tools introduced in this article can aid communities in the development of flexible, scenario- based approaches for addressing wildfire adaptation in different situations. Processes outlined in the article also serve as a unifying way to document, test, and advance flexible approaches professionals can use to work with local populations in the co-development of wildfire management strategies.

Keywords: wildfire, social diversity, Wildland Urban Interface, adaptive capacity, comanagement

Both science and policy acknowledge the important influence that social dynamics have on the increasing complexity of wildfire management (McCaffrey 2015, Pyne 2015, Steelman 2016). It is for those reasons that one focus of current wildfire science and management in the United States revolves around promoting a more sustainable relationship between fire and human populations living in the Wildland Urban Interface (WUI)—or the area where wildland vegetation abuts or intersects with human development (Fischer, Spies, et al. 2016, Smith et al. 2016). Efforts to foster US WUI populations who can "live with fire" are now subsumed under the broad policy goal of creating "Fire Adapted Communities" (FAC). FACs are composed of people who effectively adjust to changes in wildfire risk, damage, or incidence by working together. Members of FACs plan, institutionalize, and perpetuate actions that mitigate potential damages, streamline effective suppression response, and optimize efforts to recover from disastrous events (USDA and USDI 2015, FACC 2017).

Populations in FACs should recognize the ecological role of wildfire and work effectively with others, including public lands professionals, to promote landscape-level management focused on ecosystem health (Ager et al. 2015, Paveglio, Abrams, and Ellison 2016). Efforts to promote FACs give added purpose to a variety of existing programs, policies, or actions (e.g., Community Wildfire Protection Plans [CWPPs], Firewise, state fuels reduction assistance) that individuals and communities can use to promote adaptive actions aimed at reducing potential impacts or costs associated with wildfire (Williams et al. 2012, Jakes and Sturtevant 2013, Paveglio, Nielsen-Pincus, et al. 2017). As such, participation in existing formal wildfire programs (e.g., Ready, Set, Go!), performance of mitigation actions on private property (e.g., reduction of fuels around homes), and enactment of land-use planning (e.g., zoning ordinances) are examples that have become both a focus of and potential measuring stick for understanding progress toward creating FACs (see Toman et al. 2013, Alexandre et al. 2016 for examples).

While the goal of creating FACs appears sound in theory, existing wildfire social science indicates why it has been difficult to enact in practice. For instance, fostering shared responsibility for wildfire

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risk management among private citizens and land management agencies can lead to incompatible prioritizations for values-at-risk, conflict over fire management actions, and piecemeal fire mitigation strategies that fail to capitalize on collective resources (Kulig et al. 2013, Meldrum et al. 2014, Sword-Daniels et al. 2016). Studies of individual programs (e.g., CWPPs), policies (e.g., Healthy Forests Restoration Act [HFRA]), or initiatives (e.g., mitigations on private properties, evacuation planning) all indicate that no one strategy is uniformly adopted by all populations in the WUI (Brenkert-Smith 2011, Paveglio, Carroll, et al. 2012, Stidham et al. 2014, McCaffrey 2015). In sum, there is a tendency for current policy or practice to treat diverse human populations that live in the WUI as homogeneous—yet existing experience and a growing body of research demonstrate how social and ecological heterogeneity necessitates different approaches for wildfire adaptation in different places (Paveglio, Moseley, et al. 2015, Nielsen-Pincus et al. 2015, Carroll and Paveglio 2016).

Few academic, policy, or agency approaches to wildfire management effectively incorporate the many elements of local social context (e.g., local ecological knowledge, dynamic leadership, socio-demographic trends, adoption of fire science programs) that influence variable adaptation among human populations in response to increasing wildfire risk (Ager et al. 2015, Stasiewicz and Paveglio 2017). This paper focuses on the use and application of one such approach, the Interactional Approach to Adaptive Capacity (hereafter the interactional approach). The interactional approach allows stakeholders the opportunity to systematically document how combinations of empirically identified local characteristics operating in a given place might influence differential human capacities for adapting to wildfire. Use of the interactional approach has also provided early means to characterize common "groupings" of social context across locations (Paveglio et al. 2009, Paveglio, Carroll, et al. 2012, Paveglio, Moseley, et al. 2015, Paveglio and Edgeley 2017).

Our efforts in this paper serve to extend and conceptualize use of the interactional approach in a number of ways, including: (1) providing additional detail concerning the ways that residents or professionals can use the interactional approach to document, compare, and understand variable wildfire adaptation among diverse human populations; (2) synthesizing existing literature to produce key considerations or wildfire adaptation approaches that are likely to vary across populations; and (3) catalyzing insights from steps one and two to hypothesize a range of fire adaptation "pathways" that can be applied variably across populations to facilitate the ongoing evolution of people and wildfire in a dynamic local system. Each "pathway" would specify a distinct combination of incentives, actions, and potential policies corresponding with existing community "archetypes" derived from the interactional approach. A given pathway best reflects the social dynamics, ecological stressors, and accepted institutional or governance functions that people in a particular "type" of community would be able and likely to enact (see Paveglio, Moseley, et al. 2015, Carroll and Paveglio et al. 2016 for argument). This paper takes the further step of introducing "pathways" for two existing archetype communities to demonstrate their potential practical utility in fire planning. We argue that developing science and practice surrounding the evolution of these variable pathways can provide a practical—and ultimately more efficient—way for achieving landscape-level wildfire management and FACs.

Our efforts to propose the first details of variable fire adaptation pathways based on existing literature serve a number of practical and theoretical purposes for residents, managers, and researchers. To begin, it can help synthesize the disparate collection of factors influencing human adaptation to wildfire. Development of FAC pathways can help translate scientific findings into broader narratives that managers or residents can use collaboratively to harness their place-based knowledge of local dynamics in charting a path for adaptation that best fits their local context. Local context encompasses a number of factors, including the relationships and history residents have with the landscape, interactions among residents at risk from wildfire and with officials managing wildfire, ongoing demographic changes, and social norms (Paveglio, Abrams, and Ellison 2016). FAC pathways also can aid the process that different populations use to agree upon common inputs or responsibilities for managing wildfire across broader landscapes. This includes identifying the specific needs individual communities have for outside resources to help in the adaptation process and identifying the circumstances in which particular kinds of outside intervention might be counterproductive. Finally, generating preliminary "fire adaptation pathways" can provide a set of testable hypotheses and associated data collection methods that researchers or managers can use to gauge variable progress toward fire adaptation (see Ager et al. 2015, Spies et al. 2014 for requests) across diverse populations. It would include a set of steps different populations can utilize, adapt, or expand to help explain results across cases.

Making the Case for Fire Adaptation "Pathways"

Social Complexity and the Need for a "Science of Practice"

One reason that scientists and policymakers have been unable to determine a generalizable set of incentives, initiatives, or influences that can be used to create FACs is the tremendous social diversity and dynamism that exists in the WUI (Jakes et al. 2011, Paton and Buergelt 2012, Spies et al. 2014). The WUI (sometimes referred to as the peri-urban landscape) contains diverse residents, management agencies, organizations, and private industries. Each may have different relationships with the landscape, perceptions of wildfire risk, capacities to manage fire impacts, and willingness to reintegrate wildfire as a natural process (Paveglio et al. 2009, Jakes and Sturtevant 2013, Champ and Brenkert-Smith 2016). Human values, relationships, and demographics in the WUI are likely to be changing at different rates. For these reasons, the scale, motivations, and expression of human action in response to wildfire may differ dramatically across places and populations that are increasingly defined both by ecology and by the modifications that human populations generate (explicitly or implicitly) on the landscape (Cohn et al. 2008, Brunson and Tanaka 2011, Kulig and Botey 2016, Sword-Daniels et al. 2016). Likewise, the ever-changing footprint of the WUI all but ensures a future increase in its social diversity (Thomas and Butry 2014, Martinuzzi et al. 2015).

The important need to integrate diverse perspectives in a fragmented management landscape is one reason for the increased interest in the co-management of wildfire—or the process whereby diverse stakeholders operating in fire-prone environments might promote learning and governance that reflects their common needs (Berkes 2009, Abrams et al. 2015, Olson et al. 2015). Interest in the co-management of wildfire highlights the need for alternatives to scientific and policy approaches that seek universal or generalizable solutions. It also reflects a focus on process-based, deliberative

solutions that allow diverse stakeholders the opportunity to collaboratively plan how their shared decisions will affect natural resources in the future (Wise et al. 2014, Murphy et al. 2017). For instance, Williams (2017) recently remarked that natural resource management has a critical need to focus on a "science of practice," and not just the "practice of science." His arguments join a larger chorus of voices recognizing that science should be used to help affected populations make informed and adaptive choices that best fit the variable context shaping the places that matter to them (McFarlane et al. 2011, Flint 2016, Bosomworth et al. 2017). Such notions match well with the co-management of wildfire risk by acknowledging that at least some of the innovation and foci in science should be centered on ideas generated in practice, and by those who are tasked with the adaptation it seeks to engender (Goldstein and Butler 2010, Brunson and Tanaka 2011, McGee et al. 2016). It also portends a significant shift away from the top-down, universalistic approaches that have characterized management of US federal lands since the Progressive Era (Hays 1959, Fischer et al. 2013).

One critical need for wildfire management in complex landscapes will be the co-development of knowledge and shared understandings about the roles that each distinct human population or stakeholder group can play in comprehensive approaches to "live with fire" (Williams 2013, 2014, USDA and USDI 2015). This includes how each population can contribute resources, tolerance, or support as part of a "social contract" for managing across boundaries (Ager et al. 2017, Smith et al. 2016). Purely deterministic approaches to wildfire management that do not consider local perspectives, history, and functioning run the risk of stifling local adaptation by promoting "one-size-fits-all" solutions.

A "science of practice" for wildfire would likely need to provide a range of potential mitigation actions, incentives, or policies to address wildfire risk among people with the collective ability to address them, including the uncertainties associated with various adaptation options. We are referring to these options as "pathways" (Paveglio, Carroll, et al. 2012, Paveglio, Moseley, et al. 2015, Paveglio, Nielsen-Pincus, et al. 2017, Hulse et al. 2016). The notion of wildfire adaption pathways developed in parallel to climate change research stressing the importance of collaborative processes for adaption given uncertainties in future ecosystem functioning. Both streams of literature utilize ideas about "pathways" to promote shared stakeholder engagement in management, iterative learning processes, and consideration of variable strategies (O'Brien 2012, Bosomworth et al. 2017). However, our efforts in this paper focus primarily on developing variable pathways comprised of linked actions, policies, and programs that will serve as practical strategies for addressing wildfire risk across different communities, while climate change adaptation pathways often focus more on addressing future uncertainties in ecosystem function across larger regions.

Conceiving of wildfire adaptation using a variety of potential pathways would allow scientists and outreach personnel to work with—or in the service of—local actors and decision makers to provide the tools, information, or processes that help them evaluate the best way forward given their unique, place-based issues and challenges. A "science of practice" likely should not assume that generalizable results are immediately possible, or that they can be applied uniformly across populations given the temporal and spatial forces that are constantly changing the makeup of the WUI (Gosnell and Abrams 2011, Spies et al. 2017). For that reason, our next section discusses the important consideration of scale in determining how to plan for or study differential wildfire adaptation that is at the core of creating FACs. We also outline how a particular view of "community" can help explain differential progress toward FACs.

The Importance of Scale and Community in Fire Adaptation

A number of authors and policy advocates suggest the need to "scale up" wildfire mitigation efforts from individual properties to the landscape level through efforts such as CWPPs, "Fire Smart Territories," or the Collaborative Landscape Restoration Program (CFLRP) (Tedim et al. 2016, Ager et al. 2017). Inherent in those approaches is a perceived need to bring together diverse stakeholders, agencies, landowners, and interest groups to promote coordinated actions that help reduce unwanted outcomes across landownerships (Steelman 2016, Shindler et al. 2017). A lack of biophysical knowledge or science—for instance the historical occurrence of wildfire risk, strategies for the management of vegetation, or ways to reintroduce prescribed fire—often are not identified as the most significant barriers to actions such as CWPPs or CFLRP programs. Rather, it is the task of bringing together diverse populations with different values, worldviews, or abilities that often is described as a critical limiting factor (Petty et al. 2015, Fischer, Spies, et al. 2016, Charnley, Spies, et al. 2017, Charnley, Kelly and Wendel 2017). The differing actions utilized to reduce wildfire risk across distinct populations (e.g., enactment of zoning regulations, municipal codes, fire suppression policies) can create divergent "micro-habitats" of rules, resources, and ecological conditions that serve as a barrier to any agreement or action for addressing landscape-level management. Such social fragmentation must be acknowledged when planning how diverse populations can develop partnerships to address wildfire risk at large geographical scales.

Given the above argument, we suggest there is a critical need for early understanding and documentation of the circumstances that influence divergent local approaches to wildfire (McCaffrey et al. 2011, Nielsen-Pincus et al. 2015, Paton et al. 2015). Documenting influences on divergent local approaches includes recognizing the scale at which collective action can currently take place (Wilkinson 1991, Jakes et al. 2007, Christensen and Krogman 2012). It also means collecting comprehensive, systematic data at a scale (or a flexible unit of analysis) that provides insights or benchmarks for monitoring progress toward fire adaptation and facilitating the co-development of knowledge leading to consistent action (Jakes et al. 1998, Flint et al. 2008, Ross and Berkes 2014). Only then can researchers, managers, and policymakers work with—and across—populations to identify linked sets of policies, programs, and strategies that can be applied concurrently to support local action (i.e., pathways). Likewise, recognition and enactment of those variable pathways across populations can eventually "scale up" collaborative efforts to the landscape level by allowing different communities to contribute variable skills and resources that other communities may need.

Unfortunately, wildfire science has long suffered from a lack of comprehensive or consistent data regarding the ways that human populations and their associated institutions (e.g., local governments, norms and values, policies) influence the management of wildfire and associated processes (e.g., impact of suppression resources, conflict surrounding active forest management, support

for management standards) (Toman et al. 2013, Dunlop et al. 2014, Paveglio, Carroll, et al. 2016). Our efforts in this paper articulate how one emerging approach for understanding the influence of social context on wildfire management can be used as a tool for building consistent protocols about variable wildfire adaptation across communities.

The emerging focus on FACs suggests that human communities are a crucial unit for advancing human adaptation to wildfire (USDA and USDI 2015, FACC 2017). However, the term "community" means different things to different observers. Decisions about what constitutes community will heavily influence the ways in which researchers or policymakers assess progress toward fire adaptation, how their work contributes to landscape-level efforts, and what local context influences differential support for management efforts. The following paragraph specifies what we mean by "community" when discussing the development of FAC pathways.

Community is a concept that a number of authors maintain is best understood as an emergent and context-specific process of human interaction (Wilkinson 1991, Theodori 2005, Manzer and Luloff 2017). This definition fits well with discussions about the co-development of knowledge and goals for a "science of practice" in that it recognizes the need for a flexible unit of analysis reflecting the ways that local people identify themselves (Lee 1991, Jakes et al. 1998, Williams 2017). Paveglio, Boyd, and Carroll (2017) contend that the idea of community as an interactional field (Wilkinson 1991, Theodori and Kyle 2013) provides the most useful approach for understanding collective action. Community as an interactional field focuses attention on the ongoing *process* through which people build or perpetuate local functions (e.g., emergency response, provision of food and water) based on shared meanings, values, concerns, and relationships with the landscape (e.g., resource extraction, preservation, modification, etc.). It also acknowledges the long-standing influence that local context and culture (e.g., subjective norms, peer pressure, etc.) can have on individual resident action on their private properties (Flint et al. 2008).

Community Adaptation and the Interactional Approach

Paveglio et al. (2009; see also Paveglio, Carroll, et al. 2012, Paveglio, Moseley, et al. 2015, Paveglio, Abrams, and Ellison 2016, Paveglio, Nielsen-Pincus, et al. 2017) drew from existing literature to propose a theoretical approach for understanding or facilitating divergent community action in response to wildfire (for instance, see Lee 1991, Wilkinson 1991, Daniel 2007, Norris et al. 2008, Ford et al. 2010). Central is the notion of adaptive capacity, or the ways that local context influences collective will, resources, and the structure of collaborative efforts that stakeholders can leverage when determining how to reduce their exposure to or impact from disturbances (Norris et al. 2008, Paton et al. 2015, Wyborn et al. 2015). Paveglio et al. 2009, Paveglio, Carroll, et al. 2012, Paveglio, Boyd, and Carroll 2017, Paveglio, Nielsen-Pincus, et al. 2017) Interactional Approach to Adaptive Capacity (hereafter the interactional approach) was developed across a series of cases and papers. Applying the interactional approach to the goals of this paper, including the development of pathways, necessitates that it be seen as an interactive system that serves three primary and linked purposes: (1) identification of unique communities that may respond to wildfire or associated natural resource management actions differently from one another; (2) a means to explain why populations do or do not adopt programs, policies, or practices designed to help them better "live with fire" in their locality; and finally, (3) a means to understand which programs, policies, or approaches (including those that are not yet sanctioned) might be most effective given the existing local context of a particular setting (Paveglio et al. 2009, Paveglio, Carroll, et al. 2012, Paveglio and Edgeley 2017). Our interest in hypothesizing pathways for diverse communities places primary focus on advancing the third use described above, but the approach requires a theoretical understanding of the first two tasks in any given place as prerequisites (Paveglio, Moseley, et al. 2015). Thus, we contend that the interactional approach builds on legacies promoting a "science of practice" by identifying the reasons that differential adaptation might be necessary and providing a means to co-design different policies or flexible responses that support ongoing processes of adaptation among diverse communities.

The interactional approach organizes approximately 21 characteristics of local social context that are empirically documented as important influences on adaptation to wildfire in a given place. These characteristics are organized into four broad conceptual categories (see Figure 1 for existing overview, Paveglio et al. 2009, Paveglio, Carroll, et al. 2012 for description). Not all characteristics need to be present in each place; rather, they serve as a comprehensive corpus of potential influences on collective action. Each characteristic in the interactional approach can have variable expressions, ranging from the presence or absence of existing organizations with enforcement capacity (e.g., codes or standards for housing construction) to the nature of place attachment (e.g., as a place for privacy and opportunities to interact with nature vs. as a tight-knit and exclusive social group) (Carroll and Paveglio 2016, Paveglio, Nielsen-Pincus, et al. 2017). The four conceptual categories and individual characteristics outlined in Figure 1 can help facilitate quicker understanding of interrelated characteristics and promote the idea of community as a set of interdependent parts that interact to produce a comprehensive narrative of influences on collective action. That narrative can help stakeholders plan for the way that associated populations respond to and (re)produce approaches to wildfire as part of local culture (Jakes et al. 2010, Paveglio, Abrams, and Ellison 2016).

Studies have used the interactional approach to document how specific communities may react differently and consistently with regard to management strategies prior to (e.g., Firewise communities USA program, mitigations around homes), during (e.g., evacuation preferences, prioritization of values-at-risk), and after wildfires (e.g., recovery needs, aid or rebuilding foci) (see Paveglio et al. 2010a, Paveglio, Carroll, et al. 2012, Paveglio, Nielsen-Pincus, et al. 2017, Jakes and Langer 2012, Stasiewicz and Paveglio 2017, and Paveglio and Kelly 2018 for examples). Users of the interactional approach can add new characteristics to the corpus of existing social context characteristics outlined in Figure 1 to further advance understanding of differential response. Our synthesis of the interactional approach suggests that the result is a more comprehensive *understanding* of or *entry point* for the co-development of strategies and communication efforts surrounding wildfire adaptation efforts. It also is important to note that the interactional approach is not meant to deductively predict action, but to inductively aid stakeholders in the identification of their best "path" forward (Paveglio, Carroll, et al. 2012, Paveglio, Moseley, et al. 2015).

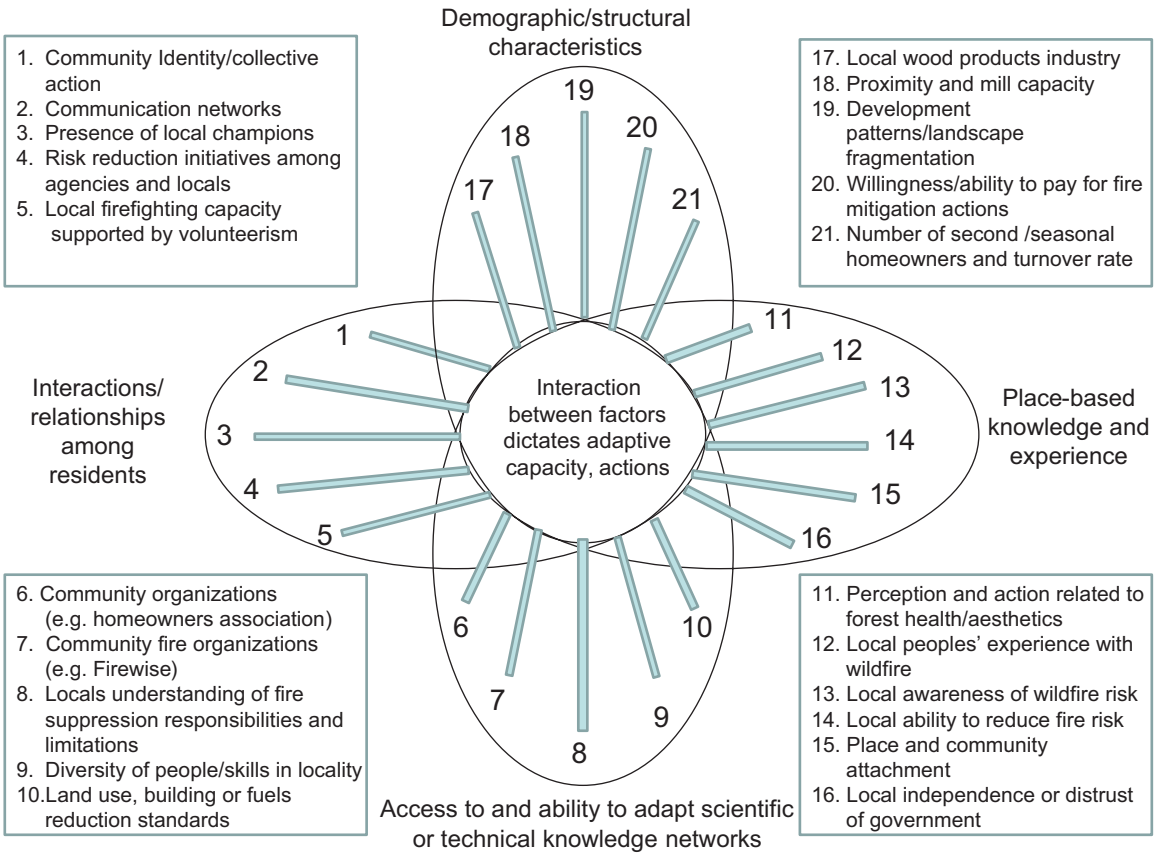

Figure 1. Characteristics influencing differential adaptation to wildfire among diverse communities (adapted from Paveglio et al. 2012).

Each numbered characteristic in Figure 1 is represented as a linear bar in order to reflect that different communities may possess varying degrees or levels of each characteristic. The length of these bars does not necessarily reflect the magnitude of characteristics.

Those interested in utilizing efforts such as the interactional approach often call for ways to more quickly generalize community and patterns of conditions across large geographic areas. Paveglio, Moseley, et al. (2015) began that process by using the interactional approach to identify consistent patterns of social context, or "archetype" communities, across 18 diverse case studies (see Figure 2 for progression). A later study (Paveglio, Nielsen-Pincus, et al. 2017) used a quantitative, scalar operationalization of Paveglio et al.'s (2012) characteristics to demonstrate how key informant evaluations of local social context across 72 locations in the US West resulted in four community "groupings" with significantly different levels of social context factors. Archetype communities are likely to respond to wildfire risk initiatives or impacts in similar ways due to similarities in their social context. We would suggest that the archetypes provide another step for applying the interactional approach in that they outline an existing means through which to compare new cases with existing lessons (see Figure 2).

It is important to remember that the archetypes only organize similar narratives of conditions, and not all communities will be exactly alike in their responses. They represent a continuum of considerations (rural vs. urban, defined vs. diffuse populations) or characteristics (e.g., ability to conduct fuels reduction, trust in government agencies) that can evolve over time in response to cultural or demographic changes (Paveglio et al. 2009, Paveglio, Abrams, and Ellison 2016). Thus, the archetypes have the capacity to provide generalizable lessons about wildfire adaption across complex conditions (Paveglio, Moseley, et al. 2015, Carroll and Paveglio 2016, Paveglio, Abrams, and Ellison 2016).

Recognition and use of the community archetypes was one basis for policymaker, researcher, or manager calls to develop and test differential pathways that communities across a continuum of social conditions might use to best support their progression toward FACs (Ager et al. 2015, Smith et al. 2016, Abrams et al. 2015). Developing, testing, and ultimately implementing FAC pathways first requires a process for organizing the range of policies, incentives, or practices that will comprise different pathways across communities. Existing case studies and research can then be used to propose initial pathway components that differ across the community archetypes uncovered in existing research. Proposed pathways for communities might serve as an initial set of testable hypotheses to help refine or guide the application of different strategies for addressing wildfire adaptation in unique conditions. Our efforts in the remainder of the paper advance research using the interactional approach and link it to the development of FAC pathways. More specifically, we synthesize existing research to articulate the considerations and specific components that would comprise variable fire adaptation pathways for diverse communities at risk from wildfire.

Organizing Considerations for Achieving FACs

Table 1 presents a set of broad considerations that are frequently mentioned in existing literature or programs as important means to

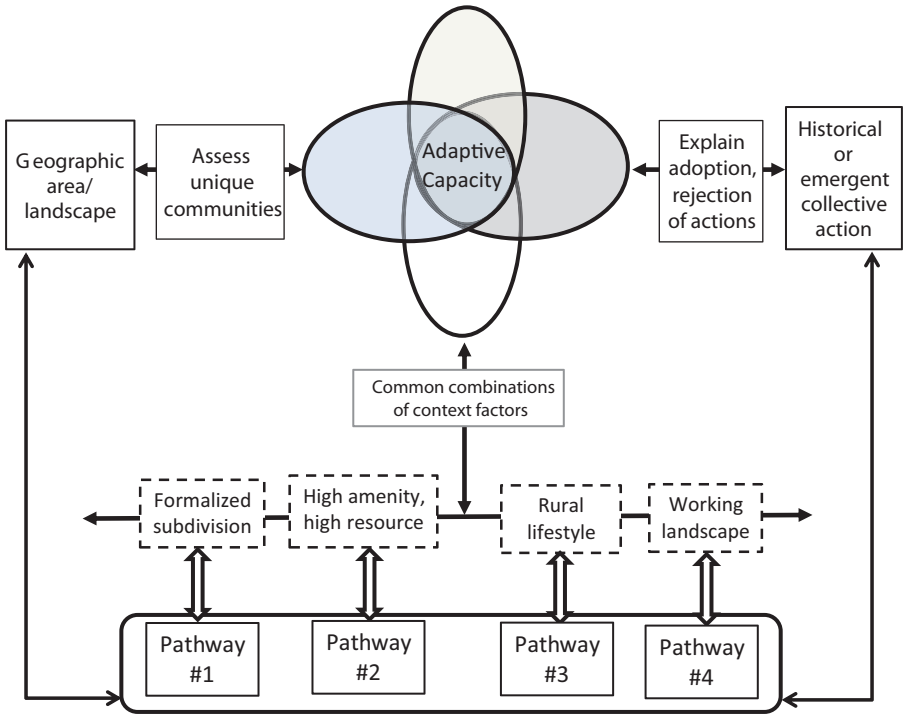

Figure 2. Development and uses for the Interactional Approach to Adaptive Capacity. The approach can be used to determine unique communities in a geographic area, explain emergent or historic collective action, or identify potential strategies best suited to local context through the systematic documentation of local social context. Meta-analysis of cases using the interactional approach has uncovered a continuum of "archetype" communities (e.g., formalized subdivision; high amenity, high resource) that share common combinations of social context. Each "archetype" community would likely have a different "pathway" for fire adaptation.

advance fire adaptation and progress toward FACs. They each represent sets of strategies, incentives, or policies that existing research demonstrates may be enacted or supported differently across diverse communities. Within each consideration outlined in Table 1 is a range of example implementation options, and we provide examples for some of those options in the second column of the table. Variable support for or implementation of different options within each of these categories can be understood as a function of differential local context across cases, and can be documented consistently using the interactional approach as described above. That is, researchers, policymakers, or residents could understand which pathways are most applicable to their community by: (1) cataloging the unique combination of social context characteristics provided in the interactional approach (see Figure 1); (2) determining how the unique combination of characteristics present in their community creates an overall narrative for the community; (3) comparing their conditions to other communities with similar context (e.g., archetypes); and (4) choosing to enact pathways that existing research suggests will be most effective for their particular archetype/local context (see Figure 2). Thus, the broad considerations outlined in this table represent a set of initial categories around which to build variable pathways for achieving FACs in different settings.

For instance, our first category of Table 1 reflects a diverse body of research indicating how different incentives, policies, or requirements might vary across diverse social contexts when promoting property-level mitigations among private citizens at risk from wildfire. Some authors indicate how programs such as Firewise can be an effective way to influence resident performance of mitigations on their properties or incentivize fuels reduction through associated grants. Other cases demonstrate that programs like Firewise might not resonate with longer-term populations who already understand how to reduce fuels on their property, who do not wish to join formal programs, or who are distrustful of associated government cost-share grants (see McGee 2011, MacDougall et al. 2014, Paveglio and Kelly 2018 for examples). Neither of these perspectives is "right" or "wrong." They each have utility in different contexts, and a science of practice can be of service in helping professionals or residents understand when Firewise is most likely to be effective in promoting local adaptation. Likewise, a number of authors argue how strict planning and zoning or building codes can reduce future wildfire risk. However, there are many regions where planning and zoning will not be supported politically and by local residents. In other cases, existing development already increases risk to the point where such broad proclamations are not likely to be cost-effective and/or locals will not support enactment of additional land-use regulations (Yin 2010, Syphard et al. 2013, Mockrin et al. 2016).

Each of the categories in Table 1 outlines a set of considerations that any community and associated institutions would likely need to agree upon in order to move forward with a comprehensive pathway for adapting collectively to wildfire. For instance, the form of governance and collaboration surrounding wildfire or natural resource management has long been a debate among professionals and scholars. US policy or law such as the Healthy Forests Restoration Act (HFRA) can be used to mandate or incentivize management action such as Community Wildfire Protection Planning (CWPP) or fuels reduction in the WUI (Brummel et al. 2010, Jakes et al. 2011, Steelman 2016). Yet in other settings, informal rules or norms among highly connected populations may build more local capacity through the promotion of grassroots

Table 1. Literature-driven considerations for proposing diverse wildfire adaptation "pathways."

Broad considerations for adaptation or collective action	Example considerations	Recent literature substantiating considerations
Ways to promote property-level residential adaptation	• Voluntary incentives (e.g., insurance premium reduction) vs. formal regulations (e.g., building codes). • Density of homes, development potential, or political will to enact regulations • Collective mitigation programs (e.g. Firewise) • Resident perceptions or values about wildfire risk	Mueller et al. 2009, Newman et al. 2013, Dennison et al. 2014, Dunlop et al. 2014, Dickinson et al. 2015, Alexandre et al. 2016, Champ and Brenkert-Smith 2016, Penman et al. 2016, Paveglio and Kelly 2018
Governance model/structure of collaborative processes	• Top-down (e.g., government policy or law) vs. grassroots organization (e.g., normative rules) • Formal planning programs (e.g., Community Wildfire Protection Plans) • Roles of local institutions (e.g., Rural Fire Protection Districts) and agencies (e.g., state lands, US Forest Service)	Olsen and Shindler 2010, Jakes et al. 2011, Williams et al. 2012, McCaffrey et al. 2013, Abrams et al. 2015, Neale and Weir 2015, McGee et al. 2016, Tedim et al. 2016, Fischer and Jasny 2017
Fuels mitigation foci	• The scale and type of fuels reduction treatments (e.g., fuel breaks, home ignition zone treatments, prescribed fire) • The goals of fuels reduction (e.g., risk reduction, landscape health, net return on timber) • Policy/planning impetus or guide (e.g., CFLRP, state fuels reduction plan)	Goldstein and Butler 2010, Collins 2012, Schultz et al. 2012, Blades et al. 2014, Stephens et al. 2016, Charnley, Spies, et al. 2017, Diaz et al. 2016, Eckerberg and Buzier 2017, Prato and Paveglio 2018
Adaptation leadership and relationships	• Agency leadership vs. local citizens (e.g., BLM vs. local homeowners association) • Level of representative involvement from various entities (e.g., emergency services, extension agents, local politicians, etc.) • Form of agency or institution input (e.g., consultation, organization, sponsorship)	Brummel et al. 2010, Butler and Goldstein 2010, McCaffrey et al. 2013, McLennan and Eburn 2014, Koebele et al. 2015, Spencer et al. 2015, Canadas et al. 2016, McGee et al. 2016, Charnley, Kelly, and Wendel 2017
Wildfire response/interaction with Incident Command (i.e., firefighting) teams	• Evacuation preferences or stay and defend • Prioritizing values-at-risk (e.g., structures vs. forage vs. sensitive species) • Local contributions to firefighting (e.g., resources, knowledge) • Conflict or support surrounding firefighting tactics	Kent et al. 2003, O'Neill and Handmer 2012, Paveglio, Boyd, and Carroll 2012. Paveglio, Moseley, et al. 2015, McCaffrey et al. 2015, McLennan et al. 2015, Nowell and Steelman 2015, Andresen 2017, Stasiewicz and Paveglio 2017
Wildfire impacts/short or longer-term recovery	• Impacts to locals (e.g., "loss of landscape" vs. "loss of livelihood" vs. loss of infrastructure) • Post-fire landscape rehabilitation needs • Post-fire assistance needs (e.g., housing assistance vs. slope stabilization) • Structure of recovery networks (e.g., volunteer efforts, FEMA)	Olsen and Shindler 2010, Jakes and Langer 2012, Jakes and Sturtevant 2013, Stephenson et al. 2013, Paveglio, Brenckert-Smith, et al. 2015, Paveglio and Edgeley 2017, Reid and Beilin 2015, Kulig and Botey 2016, Mockrin et al. 2016
Structure of mitigation aid or grants	• Most effective means to allocate resources (e.g., state cost-matching grants vs. community development organizations) • Type of mitigation aid (e.g., education, consulting or monetary) • Role of scientists or extension agents (e.g., technical assistance vs. project lead)	Ojerio et al. 2011, Collins 2012, Fischer 2012, Busby et al. 2013, Davis et al. 2014, Milne et al. 2014, Monroe et al. 2015, Penman et al. 2015, Petty et al. 2015, Edgeley and Paveglio 2018
Resource management foci	• Resource utilization vs. resource management • WUI focused vs. landscape-level health or restoration • Considerations for wilderness and other protected areas	Ryan and Hamin 2008, Paveglio, Carroll, et al. 2012, Burtz and Bright 2014, Nielsen-Pincus et al. 2015, Diaz et al. 2016, Hjerpe et al. 2016, Eckerberg and Buizer 2017
Means of communication, message framing	• Formal channels (e.g., media, extension publications) vs. informal networks (e.g., word-of-mouth, local clubs) • Message source and legitimacy (e.g., Joint Fire Knowledge Consortium, local firefighters) • Message content and focus (e.g., potential damage to property vs. benefits of management to ecosystem)	Champ et al. 2012, Paveglio, Carroll, et al. 2012, Williams et al. 2012, Ascher et al. 2013, Toman et al. 2013, Ager et al. 2015, Fischer, Vance-Borland, et al. 2016, Anton and Lawrence 2016, Velez et al. 2017

solutions that integrate into the "social fabric" of a place and perpetuate beyond initial subsidies tied to policy requirements (Brenkert-Smith 2011, Paveglio, Carroll, et al. 2016, Tedim et al. 2016).

It also is important to note that the considerations or associated options in Table 1 may not be mutually exclusive. They are likely to interact in ways similar to the social context characteristics that the interactional approach uses to help explain their variable

expression (see Paveglio, Abrams, and Ellison 2016, Carroll and Paveglio 2016 for discussion). It is because of this interconnectedness (or multicollinearity) that thinking comprehensively across the considerations in Table 1 holds promise for promoting consistent pathways. Implementation decisions within each of the considerations in Table 1 are most likely to be effective when they complement one another, and reflect the underlying social values or interactions that make them well suited to the social-ecological systems they are designed for. For instance, considerations about governance structure or collaboration between local groups, agencies, or government entities clearly interact with the "adaptation leadership and relationships" consideration of Table 1. That latter category might include decisions about who will lead collaborative efforts to reduce wildfire risk or manage ecosystem processes in a way that includes fire as a valuable ecosystem process. The form of collaborative governance or policy agreed upon in a given community context might mandate that certain individuals take initial leadership roles (e.g., emergency management professionals, federal agency representatives). However, other situations may require local citizen champions or homeowners associations to take the lead, including places where no formal regulation exists (or will be supported) (see Butler and Goldstein 2010, Champ et al. 2012, Abrams et al. 2015, Canadas et al. 2016 for examples).

One enduring consideration for wildfire management is the way that temporal "phases" of hazards reflect an ongoing process of human adaptation to their local circumstances (McCool et al. 2006). Considerations outlined in Table 1 span the before, during, and after periods often used to help organize needs surrounding different adaptation actions. For instance, our "wildfire response/interaction with Incident Command (i.e., firefighting) teams" category concerns actions that will be taken during a wildfire event, which have been demonstrated to vary across populations. For another example, existing research indicates how members of some communities may be more likely to criticize firefighting efforts (Kumagai et al. 2004, Carroll et al. 2005, Kumagai et al. 2006).

Other efforts indicate diverse prioritization of values-at-risk (e.g., timber or forage, residential structures, community watersheds, viewsheds, or recreational opportunities) across populations during wildfires. The legacy of potential conflict or cohesion surrounding wildfire management decisions during an event can influence the trajectory of recovery following such events, including the actions that local residents and governments might plan for in the future (Olsen and Shindler 2010, Jakes and Sturtevant 2013, Paveglio and Edgeley 2017). Our category of "wildfire impacts/short or longer-term recovery" reflects variation across populations by indicating how populations may be differentially impacted by a given fire event (Milne et al. 2014, Paveglio, Brenkert-Smith, et al. 2015).

While some populations may be most affected by a "loss of the landscape" that stems from consumed vegetation in special recreation areas, others may be concerned about a "loss of livelihood" in the form of lost timber, crops, fencing, or animals (Kent et al. 2003, Brunson and Tanaka 2011). Different impacts also may give rise to divergent post-fire assistance needs (e.g., slope stabilization, housing assistance) that are the primary responsibilities of different state and federal agencies, and which would require variable planning for collaboration between entities (Burns et al. 2008, Stephenson et al. 2013, Paveglio, Carroll, et al. 2016, Smith et al. 2016).

Finally, it is important to recall that actions associated with each of the considerations in Table 1 are the product of diverse individuals and communities that influence landscape dynamics beyond their private properties (including public lands). Our consideration of "resource management foci" reflects enduring differences among people regarding the utilization, restoration, or strict preservation of natural resources, including nearby public lands. The size of a given community, community members' conception of responsibility for public lands, and their views about the impact of human management on the landscape may result in variable support for or collaboration on fuels mitigation or resource management beyond their properties (Nielsen-Pincus et al. 2015, Reid and Beilin 2015, Eckerberg and Buizer 2017).

Providing the logic for each category in Table 1 is a difficult endeavor to outline in a single manuscript, but we have provided supporting literature for each consideration to demonstrate how they reflect ongoing science surrounding wildfire and natural resource management. Potential variance in the implementation of these considerations across populations can be paired with the social context characteristics or overall narratives that result from the interactional approach. That pairing can begin the process of designing and "tailoring" sets of linked strategies that might be effective starting points or guidelines for continued community adaptation toward different goals for FACs. We turn toward next steps for this overarching task in the next section.

Proposing Pathway Components for Archetype Communities

A logical next step in the progression toward tailored "pathways" for FACs is proposing or hypothesizing different outcomes for the considerations outlined in Table 1 across existing classifications of diverse social conditions. Accordingly, this section advances case-study research conducted by the authors and existing wildfire social science literature by proposing potential pathway components for two community archetypes outlined by Paveglio, Moseley, et al. (2015): (1) High Amenity, High Resource communities (hereafter "High Amenity"); and (2) Working Landscape/Resource Dependent WUI communities (hereafter "Working Landscape"). We summarize hypothesized differences in Table 2, and we explain select examples in the following paragraphs. We chose to compare the High Amenity and Working Landscape archetype communities because of their relatively divergent social context along the continuum of existing WUI community archetypes and because a full presentation of hypothesized pathways for all archetypes would make our effort (and Table 2) too complex for presentation in one article. The pathway considerations presented in Table 2 are new to the literature, and are best understood as potential means to approach the co-management of wildfire among diverse stakeholders, including dialogue points for the co-development of knowledge or ideas necessary to advance fire adaptation actions.

Comparisons across archetypes outlined in Table 2 begin to indicate how the legacies of local values, working relationships, and preferences in diverse communities might require divergent means to approach broad considerations for achieving FACs. For instance, existing research and observation suggest that communities with High Amenity characteristics are more likely to focus fuel

Table 2. Proposed "pathway" components for advancing fire adaptation in two example "archetype" communities.

Broad considerations for adaptive or collective action	Proposed "pathway" components	
	High Amenity, High Resource WUI communities	Working Landscape/Resource Dependent WUI communities
Ways to promote property-level residential adaptation	1. Foster Firewise communities for peer pressure on individual mitigations 2. Formal standards (e.g., building materials and vegetation in Home Ignition Zone) where homeowners associations are present 3. Insurance incentives for individual mitigation actions 4. Zoning and planning to reduce future risk in new development 5. Codes and regulations for maintenance of fuels reduction 6. Potential for taxation tied to fire management	1. Home Ignition Zone (HIZ) mitigations less important due to existing local practice, values-at-risk 2. Use existing informal networks to support consistent mitigation, less likely to adopt Firewise 3. Harness farming, agricultural practices as dual means to treat private fuels 4. Zoning and planning unlikely to be supported, unless it perpetuates working lands 5. Retrofit older structures using insurance leverage, grants 6. Crop and timber insurance incentives tied to wildfire mitigation
Governance model/structure of collaborative processes	1. Trust in, willingness to work with agencies (e.g., Forest Service, state department of lands), government or environmental groups 2. More supportive of top-down regulations/codes to manage wildfire (e.g., neighborhood, state). 3. Collective action through special interest groups, organizations (e.g., civic groups, neighborhood initiatives) 4. Use Community Wildfire Protection Plans (CWPP) to prioritize community fuel reduction efforts at neighborhood scales 5. Likely to foster community-wide initiatives or groups dedicated to wildfire risk	1. Often distrustful of agencies, government higher than county level 2. Supportive of local, grassroots organizing to address wildfire risk 3. Build local organizational capacity for fire suppression (rural fire protection districts, Rangeland Fire Protection Associations) 4. Collective action through local organizations (e.g., grange, cattleman's association) 5. Willing to prioritize larger fuel treatment projects with locals, less support for formal programs or policies (e.g., CWPP). 6. Revitalize or build biomass and/or mill capacity to manage larger landscape
Fuels mitigation foci	1. Primary fuels reduction focused on WUI (e.g., HIZ), adjacent wildlands 2. Strategic fuel breaks at interface of development, large tracts of undeveloped vegetation 3. High emphasis on landscape amenity values, private property protection, watersheds 4. Management of larger landscape to preserve recreational opportunities, aesthetics 5. Landscape health, restoration focus through landscape collaboratives	1. Fuels reduction across disperse region, less residential density necessitating fuel breaks 2. High emphasis on *resource use* to reduce risk to natural resources (e.g., timber, agriculture, forage), be stewards of larger landscape 3. Develop partnerships with public agencies (e.g., Forest Service, state department of lands) to support active management 4. Leases (grazing), contracts (large timber sales, stewardship contracting) on public or private lands provide dual benefits (e.g., risk reduction and economic benefit)
Adaptation leadership and relationships	1. Agency members are partners, can introduce initiatives (e.g., foresters, outreach specialists) 2. Local resident "sparkplug" or politicians help initiate formal campaigns in concert with agency partners 3. Residents can supply grant-writing expertise or professional experience 4. Higher likelihood of paid local firefighters, emergency services ensure technical capacity 5. Efforts tend to engage or fund consultants who help achieve outcomes (e.g., fuels reduction, CWPP, burn plans) 6. Agencies can sponsor and guide efforts through expert prescription	1. Local, longtime community members are trusted points of entry, leaders 2. Extension foresters, agency managers play smaller organizing role at onset due to trust issues 3. Initiatives led locally or guided by representatives from similar areas 4. University extension, politicians facilitate collaboration between agencies, locals 5. Risk to livelihoods, landscape catalyzes action 6. Residents want directed, technical *advice, not prescriptions* from agencies 7. Local contractors, residents want to, have capacity to perform mitigation actions themselves
Incident Command teams and outside response	1. Ready, Set, Go! program likely to be effective 2. Explicit evacuation instructions for residents 3. Ingress/egress evaluations for residential development 4. Establishment of evacuation centers 5. IC teams prioritize residential property, high amenity resource values (parks, viewsheds, etc.) 6. Wildland fire suppression efforts keep the fire "away" from populated WUI boundary 7. Need for coordination with structure firefighters	1. Planning for evacuation and "alternatives to evacuation" 2. Drainage-level agreements for rural road maintenance 3. Plans for large animal protection, mobilization during fires 4. Suppression efforts may need to prioritize livelihood (e.g. timber, cattle, forage, crop) 5. ICs coordinate with, use local knowledge for access, water sources, suppression 6. Coordination with local firefighters, officials key to reducing conflict

Table 2. Continued

Broad considerations for adaptive or collective action	Proposed "pathway" components	
	High Amenity, High Resource WUI communities	Working Landscape/Resource Dependent WUI communities
Wildfire impacts/short- or longer-term recovery	1. Insurance prevalence lessens direct impact, incentivizes rebuilding or expansion of WUI 2. Short-term housing needs following structure loss 3. Potential for psychological impact among residents with less wildfire experience 4. "Loss of the landscape" with regard to aesthetic impacts (e.g., viewsheds) 5. Recovery should take into account reduced tourism, recreation opportunities 6. Landscape rehabilitation often less necessary for private properties, Burned Area Emergency Response (BAER) for nearby public lands 7. City or county emergency services coordinate recovery aid	1. Need for longer-term housing due to longer rebuild times in rural areas 2. Recovery funds funneled through local governments (e.g., county, state) 3. Recovery should take into account long-term loss of forage, crop, timber productivity 4. "Loss of livelihood or landscape" tied to historic use, impact to hunting/fishing 5. Landscape rehabilitation often focused on restoring resource productivity (e.g., timber or agriculture) and slope stabilization 6. USDA grants for crop recovery, fencing, and replanting; need for Burned Area Emergency Response (BAER) on private lands 7. Volunteer organizations, grassroots groups coordinate recovery aid across large areas
Mitigation aid or grants	1. Educational/outreach programs for residents new to wildfire-prone landscapes 2. Consultation, technical expertise for establishment of paid local firefighting 3. Development or facilitation of contractor services private residents can utilize to take personal responsibility for wildfire risk 4. Planning and zoning or emergency management preparedness grants 5. Establishment or support for biomass utilization facilities	1. Grants for resources, training to support volunteer fire departments 2. Establishment/expansion of fire protection organizations in remote areas (e.g., Rangeland Fire Protection Associations [RFPAs]) 3. Local organizations funnel cost-share mitigation grants (e.g., fuels reduction, structure retrofitting) 4. Establishment of prescribed burn councils 5. Rebuilding, expansion of wood products capacity
Resource management foci	1. Promoting healthy, "natural" landscapes 2. Special interest groups most active on nearby public lands 3. Likely to be more preservationist minded 4. Support for prescribed fire in backcountry, less near homes 5. Fuels reduction as restoration, risk reduction	1. Being good stewards of the land 2. Actively manage landscapes for multiple uses 3. Broad cross-section of residents dependent on public lands management 4. Support prescribed fire use for resource benefit, including private lands 5. Fuels reduction as economic benefit, good management practice
Means of communication, message framing	1. Protect your property investment and the landscape 2. Leave during fires and let the professionals handle it 3. Dialogue about limits of agency mandates and private property protection 4. Fire Adapted Communities Network, Joint Fire Science Knowledge Consortium, Agency representatives all good message providers due to trust in scientific expertise	1. Boost the local economy through fuels reduction and prevent catastrophic fire loss to livelihoods 2. We need your help putting out small fires (RFPA, rural fire protection), you can stay to defend your property if you are prepared 3. Local action can stave off government regulation 4. Dialogue about rules surrounding firefighting response, regulations (e.g., firefighter safety) 5. Information should pass through local contacts, groups (e.g., cattleman's association, agricultural extension, universities)

reduction efforts on the development of large fuel breaks along the edges of relatively dense developments near High Amenity tracts of public lands (i.e., fuels mitigation foci consideration) (Varela et al. 2014, Petty et al. 2015, Anton and Lawrence 2016). Those strategic fuel breaks place a high priority on the protection of private properties and keeping fire out of residential areas. Using collective fuel breaks and promoting fuels reduction treatments immediately around homes (the Home Ignition Zone) opens up opportunities for broader treatments on High Amenity lands with scenic qualities (vistas, wild and scenic rivers) or recreational opportunities that are residents' reasons for living in the area (Loomis 2004, Bihari and Ryan 2012, Hjerpe et al. 2016). Such trends indicate a need to establish collective agreements for fuel breaks across homeowners, neighborhoods, or homeowners associations. A desire to uphold tourism and recreation opportunities may result in compromise over certain forest management prescriptions that serve dual purposes (e.g., aesthetics and risk reduction) (Ascher et al. 2013, Duffield et al. 2013, Price et al. 2016).

Alternatively, we outline in Table 2 how Working Landscape communities are more likely to support or plan for fuels reduction across disperse regions and in regular spatial intervals across private and public lands. This often occurs because private properties are dispersed widely across the landscape and often interspersed with (or reliant on) public lands (Brunson and Tanaka 2011, Jakes and Langer 2012, O'Donnell et al. 2014). Residents in Working Landscape communities may have greater local capacity to partner with local governments and agencies in the performance of fuels reduction through grazing leases, timber sales, or stewardship contracting agreements. For example, Working Landscape communities are more likely to include timber industry professionals or nearby facilities who could aid in or utilize materials from fuels reduction activities. As such, Working Landscape communities are

more likely to develop active partnerships with public agencies if the goal is more active resource management (Carroll et al. 2005, Prestemon et al. 2012, Davis et al. 2014, Fischer, Vance-Borland, et al. 2016, Charnley, Spies, et al. 2017). This may mean very different ideas about forest management prescriptions when compared to High Amenity communities (e.g., species harvested, amount of biomass removed, use of prescribed fire, etc.), and whether those actions are feasible given current forest management policy or practices (Eriksen and Gill 2010, Gordon et al. 2010, Shindler et al. 2011).

Divergent pathway components in Table 2 also can concern the actions residents take during wildfire events or the way they prioritize values-at-risk from wildfire (i.e., Incident Command teams and outside response considerations). For instance, a growing body of literature and evidence suggest that members of Working Landscape communities are more likely to stay and defend their private properties rather than evacuating during wildfire events, even when predominant policy focuses on evacuation (Paveglio, Boyd, and Carroll 2012, Paveglio, Prato, et al. 2014, Handmer and O'Neill 2016). Motivations for stay and defend actions can include the need to protect investments such as animals, timber, or crops. They are often built from multi-generational knowledge and experience suppressing or utilizing wildfire in the locality (Cohn et al. 2006, Penman et al. 2016). Strategies for co-management in Working Landscape communities might respond to these conditions by better documenting which property owners intend to stay during wildfires in order to plan for safety issues, avoid confusion at road closures, or coordinate among residents who may need sheltering points.

In a broader sense, Incident Command teams or local firefighters working with Working Landscape communities can institute policies and procedures to use local equipment (e.g., dozers, sprayers, swathers) or knowledge about road access, water sources, and past fire history. Utilization of local knowledge and resources has been shown to reduce conflict among locals and agencies after fires (Carroll et al. 2006, Olsen and Sharp 2013, Stasiewicz and Paveglio 2017). Pre-planning of explicit statements outlining locals' prioritization of values-at-risk are another essential consideration for Working Landscape communities who will interface with outside fire professionals during fire events. For instance, some evidence indicates that Working Landscape communities may prioritize protection of natural resources or infrastructure above structure protection. Evacuation plans also should likely account for coordinated efforts to mobilize or stage large animals (e.g., horses, cattle, other livestock) during fires to avoid losses (Cohn et al. 2006, Paveglio, Brenkert-Smith, et al. 2015). The extent to which outside firefighters can—or will—acknowledge Working Landscape communities' prioritization given their requirements may be a critical policy question.

Existing evidence and observation suggest that communities approximating the High Amenity community archetype are less likely or prepared to stay and defend their properties (see Table 2 for full overview). These populations are ideally suited for the Ready, Set, Go! program and associated recommendations surrounding performance of quick and timely evacuation paired with home mitigations (e.g., Firewise actions) that reduce firefighter need to protect structures (Paveglio et al. 2010b, Whittaker et al. 2013, IAFC 2017). Explicit instructions and promotion of best practices surrounding evacuation (e.g., including evaluation of transportation infrastructure and capacity) would likely be key elements to plan and co-develop with residents in High Amenity communities, as would the establishment of nearby evacuation centers that could help coordinate immediate support or aid (McCaffrey et al. 2015, Velez et al. 2017, Whittaker et al. 2017). High Amenity communities may be likely to prioritize private property and structures above other values-at-risk during fires, followed by High Amenity recreation areas (e.g., ski hills, iconic parks) or impacts to watersheds (Mendez et al. 2003, Brummel et al. 2010, Busby et al. 2013). Outside firefighters will likely need to coordinate with additional rural fire protection districts or city fire departments in order to deal with the diverse equipment needs required at the interface of wildland fuels and structure fires in denser neighborhoods.

The above examples and comparisons across community archetypes in Table 2 demonstrate how local values, relationships, or physical conditions might all combine to dictate different means by which to foster adaptive actions. They also can help professionals or policymakers understand what types of suggestions are unlikely to be supported or institutionalized, and the differential types of aid that may help communities progress toward fire adaptation (i.e., mitigation aid or grants consideration). For instance, High Amenity communities are more likely to feature professionals and retirees with experience writing proposals or executing contracts and who often have significant financial resources (Paveglio et al. 2010, Collins 2012, Abrams et al. 2015). Though High Amenity communities may be successful in obtaining cost-share grants or other financial aid for wildfire mitigation due to the aforementioned skills and a comparatively high level of trust in state or federal agencies managing natural resources, availability of funds likely is not as critical a limiting factor when compared to other archetype communities.

High Amenity communities also can feature significant residential turnover or amenity migrants moving from areas where wildfire is not a common concern (Gordon et al. 2010, Newman et al. 2013, Roberts 2013). For these reasons, education or outreach programs outlining the natural role of fire in the landscape, introducing Firewise practices (which High Amenity communities are more likely to support), or providing landowners with additional technical assistance in the completion of forest management plans on private properties are likely to be key priorities. Similarly, High Amenity communities may be more likely to need aid that helps them establish taxable districts for additional paid firefighting response or that helps introduce planning and zoning initiatives that will be supported in the locality as a means to reduce wildfire risk (see Eriksen and Gill 2010, Stidham et al. 2014, Bardsley et al. 2015 for related discussions). Finally, development of local, small-scale contractors and quick means to match them with residents who need assistance preparing properties for wildfire risk (e.g., structure construction/retrofitting, vegetation management) have the potential to perpetuate enduring local capacity (and economic sectors) after initial grant investment (Steelman and Kunkel 2004, Meldrum et al. 2014).

The form and function of effective mitigation aid would likely be very different in Working Landscape communities. To begin, distrust of some government services, agencies, or aid would likely mean that any grants or subsidies to catalyze longer-term adaptation would need to be funneled through more trusted organizations that have developed working relationships with locals (e.g., university or USDA extension, community development organizations). There

may also be a need for local councils or representatives who oversee, explain, or help prioritize grants to alleviate concerns about state or federal aid imposing on private property rights. Monetary grants may be necessary for some low-income residents who need help with fuels reduction, while a larger proportion of aid could likely go toward additional equipment, facilities, training, or paid positions to build local capacity for volunteer fire or rural fire departments (see Ojerio et al. 2011, Poudyal et al. 2012). This could include the support or establishment of new organizations that allow private citizens the opportunity to aid in the early detection or suppression of wildfire such as Rangeland Fire Protection Associations or Timber Protective Associations (McCaffrey et al. 2013, Stasiewicz and Paveglio 2017). It may also mean initial support and incentives for rebuilding forest products facilities or workforce training that provide longer-term capacity for landscape management initiatives (Fischer et al. 2014, Crandall et al. 2017, Mottek-Lucas et al. 2017).

Finally, it is important to consider divergent and tailored messages that extension agents, risk communicators, and natural resource managers all recognize as critical components for fostering collaboration among stakeholders surrounding the co-management of wildfire. These messages or strong thematic statements help distill and combine elements of unique pathways. Messages should leverage multiple or overlapping benefits of broader wildfire management to motivate continued action in a given social-ecological system. Effective messaging also means thinking about the best communicators in order to advance collaborative efforts (i.e., means of communication, message framing consideration).

For instance, Table 2 outlines how central messages or themes in Working Landscape communities might revolve around collective wildfire adaption as a means to reduce risks to livelihood *and* as a means to boost local economies tied to resource utilization. Collaborating with outside entities on collective strategies for local fuels reduction may increase potential for contracts on public lands, or reduce the potential that residents and authorities clash about access to private properties during wildfire. In a broader sense, collaborations with Working Landscape communities might promote grassroots organization of fire adaptation as a means to stave off additional government regulations (e.g., planning and zoning, codes and standards, taxes) because such avoidance is likely a significant incentive for those populations. Finding effective communicators in Working Landscape communities, or developing local leaders, means seeking individuals from existing groups (e.g., timber associations, long-term farmers or ranchers from hay growers' or cattleman's associations) who are trusted among community members and who have long-term local knowledge (see Cohn et al. 2008, Stasiewicz and Paveglio 2017). Third-party organizations, such as universities or community development professionals, can serve as facilitators for land management professionals, extra-local firefighters, and locals.

In contrast, message framing or thematic statements in High Amenity communities would likely need to stress how adaptive actions on individual properties or nearby lands can help protect property investments and the existing landscape conditions that locals value. Messages central to the FAC campaign, including taking personal responsibility for wildfire as a member of the larger "community" and recognition that state and federal firefighting agencies are not intended to be private property protection, also can be central components (Steelman and Kunkel 2004, Prior and Eriksen 2013). Residents in High Amenity communities are often amenable to formal organizations, groups, or experts as communicators of messages because they have more trust for professionals or scientific knowledge (see Newman et al. 2013, Toman et al. 2014 for related discussions). For those reasons, organizations like the Joint Fire Science Knowledge Consortia, US Forest Service or Bureau of Land Management professionals, university researchers, and the Fire Adapted Communities Network might have an easier time serving as preliminary conduits of information. Local resident champions or "spark plugs" who are active in area clubs can help introduce the broader community to new ideas or coordinate efforts (see Koebele et al. 2015, Steinberg 2011).

Proposed differences outlined in this section are only broad starting points in thinking about practical strategies for incorporating diverse social-ecological conditions in wildfire management planning. We provide suggestions for further development of the above ideas and their utility for a science of practice in the final section.

Toward a Science of Practice for FACs

The purpose of this article is to articulate how a conceptual approach for understanding the social diversity of human populations at risk from wildfire could be extended to design flexible approaches for advancing progress toward FACs. Central to our efforts is the introduction of considerations that can aid in the systematic development or testing of variable "pathways." Pathways provide communities with scenario-based adaptations they can modify to advance fire adaptation in their locality (Paveglio, Moseley, et al. 2015, Carroll and Paveglio 2016, Wise et al. 2014). The ideas synthesized in this paper help advance a science of practice by providing a preliminary organizational scheme for key considerations that are likely to vary across populations in the promotion of adaptive actions (Williams 2014, 2017). We also used existing lessons and our newly developed organizational scheme to propose a set of example pathways that different "archetype" communities could implement while adapting to wildfire. Underlying both of these conceptual advancements is a need to understand and document how unique local context—and the variable expression of community—can provide us with systematic means to create tailored approaches for the co-management of wildfire across socially fragmented landscapes (Flint et al. 2008, Paton et al. 2015, Paveglio, Abrams, and Ellison 2016, Paveglio, Boyd, and Carroll 2017).

Wildfire social science has never promoted a consistent approach, set of characteristics, or process that synthesizes its considerable case-study evidence into a body of practical, implementable science (Kulig et al. 2013, Toman et al. 2013, Sword-Daniels et al. 2016). Our suggestion is that the interactional approach to adaptive capacity, when paired with our considerations for development of pathways across community archetypes, could eventually serve as a unifying way to document, test, and advance flexible approaches for addressing wildfire adaptation in different situations. That is because the process can serve as both a means to identify community and the associated scale of collective action or help explain new innovation in a way that allows other populations to assess its utility in similar situations (see Figure 2 and earlier discussion) (Paveglio, Carroll, et al. 2012, Paveglio, Carroll, et al. 2016). Collectively, the

considerations outlined in this manuscript begin to provide a set of generalizable steps, criteria, and considerations for linking important lessons about the influence of diverse local social conditions with a range of strategies or outcomes related to goals of FACs.

We are not suggesting that the characteristics currently associated with the interactional approach, developed predominantly from case-study research in the US West, are a comprehensive corpus of local context influences for all situations. However, the steps taken to develop and use the interactional approach (including the archetypes), applied to considerations for pathway development outlined in this article, provide the start of a more holistic process for iteratively assessing and monitoring the variable success of wildfire management initiatives across cases. That process should build from and reflect existing lessons (i.e., research and practice) about the characteristics of social context that are most likely to help explain the form of collective action across regions. Likewise, the processes and approaches outlined in this article should not necessarily be derived from or applied by only a select few researchers. They should be broadly agreed upon by researchers, practitioners, policymakers, and professionals associated with wildfire management operating in a given landscape.

Further development of the conceptual tools outlined in this article can serve a number of scientific and practical purposes. To begin, they provide local stakeholders with a systematic means to articulate primary components of their unique local context and discuss how that might influence the strategies, policies, or collaborative processes they will undertake in the future (see Petty et al. 2015, Tedim et al. 2016, Eckerberg and Buizer 2017 for related arguments). This outcome is likely to be useful in risk or natural resource planning, but it also serves as a good discussion point for collaboration among institutions or when aggregating efforts across socially fragmented landscapes (Murphy et al. 2017; Bosomworth et al. 2017). Consistent collection of best practices or lessons learned across communities with similar social context conditions (e.g., archetypes) can begin to aggregate a practical database of outcomes or strategies that communities could share (see Goldstein and Butler 2010, Collins 2012, Spencer et al. 2015). It also would allow for comparison across cases using a common corpus of characteristics or criteria. These efforts could be utilized by existing organizations that seek to connect human populations or communities managing wildfire risk, including the Fire Adapted Communities Network, the Firewise Communities Program, or the US Fire Learning Network (FACC 2017, Nature Conservancy 2017, NFPA 2017). Rather than prescribing the "best science" through one generalizable approach, managers and residents could use the characteristics from the interactional approach to develop a more comprehensive view of the places they care about (including multiple communities) and match these understandings to a range of potential strategies (i.e., pathways) that serve as a "menu" of fire adaptation actions.

Data collection using the interactional approach (or a similar analogue) and our considerations for pathway development (see Table 1) could be aggregated across landscapes, states, or regions to form the basis for comparative science or meta-analysis that has been sorely lacking in wildfire science (McCaffrey et al. 2015, Paton et al. 2015). It could eventually provide a baseline for consistent data collection about the enactment of flexible strategies for wildfire adaptation and complement demographic indicators commonly used to understand social vulnerability or resilience to risk (see Solangaarachchi et al. 2012, Poudyal et al. 2012 for examples).

Despite the advances outlined in this article, there remains a significant need to conceptualize and better institutionalize a science of practice for wildfire. Next steps in that process likely include proposing pathways for the other two archetype communities outlined by Paveglio, Moseley, et al. (2015) and then testing support for or use of pathways components across diverse communities. Such testing could advance development of reliable pathway components. Development of more specific practices, policies, and prescriptions comprising Table 2, or which would serve as potential pathway components for different archetypes, also could make pathways easier to implement. This includes the documentation of enabling or constraining conditions (e.g., existing laws, policies, resource regulations, resources) that might be associated with each action (O'Neill and Handmer 2012, Fischer, Spies, et al. 2016). It is important that any expansion of the characteristics in Table 1 and additional articulation of the pathways proposed here be built from empirical case studies or a cross-case comparison of real-world conditions (see Dickinson et al. 2015, Kuligowski 2016 for related points). They should utilize feedback from stakeholders as a means to expand or further develop the considerations, actions, and policy options that comprise different pathways. They also should reflect common consensus among researchers and professionals who have collaborated with diverse populations. A fruitful avenue for ongoing research might be the collaborative development and refinement of the conceptual tools outlined here, including the development of research methods that allow various participants to arrive at a common understanding of the characteristics, considerations, and pathway components that are most important for future wildfire management (e.g., multi-criteria decision analysis, Q-sort methodologies, experimental auctions, etc.).

Collecting social data using the interactional approach (or a similar analogue) will likely require the development of detailed guides or tools that help individuals recognize conceptual understandings developed by those with specialized training (Paveglio, Nielsen-Pincus, et al. 2017). While existing articles outline considerations for data collection, we would advocate further development of narrative, descriptive indicators for characteristics implicated in the interactional approach. This should likely include rich description of qualitative conditions *and* quantitative scales (e.g., Likert-question sets, choice modeling schemes) that reflect replicability and reliability across methods and cases. Both qualitative and quantitative indicators are important because existing research indicates that some important characteristics of local context are narrative or conceptual and cannot be well quantified. Meanwhile, quantification of other factors can help understand the strength of relationships among variables (Ager et al. 2015, Nielsen-Pincus et al. 2015, Paveglio, Moseley, et al. 2015, Paveglio, Carroll, et al. 2016). Residents and practitioners also may see more utility in narrative descriptions of conditions that they can match with their local context. Indicators could provide a range of conditions or expressions for each characteristic, and guidelines for how to provide indicators for new (i.e., currently undocumented) characteristics.

Finally, there is the important question of how to institutionalize data collection surrounding the interactional approach (or some similar analog), considerations for pathway development, and the form of pathway components. Development of more formal

procedures, scales, and indicators as described above could eventually be synthesized into a "pathway guidebook" that serves as both a data collection instrument and a planning tool. Stakeholders could use the guidebook as a step-by-step guide for documenting the ways that differential local conditions can be used to select or adapt a range of strategies best suited to advance co-management of wildfire risk. The guidebook also could provide example case studies and descriptions of the ways that pathways are emerging across diverse social, managerial, and ecological conditions (e.g., archetypes, ecotypes). Measures and indicators outlined in the guidebook could serve as a consistent way to collect and aggregate data on the social conditions that vary across time and space in the WUI. Completion of the scales and indicators in the guidebook could be tied to a range of grant or cost-share mechanisms that would likely vary across communities (e.g., fuel reduction or volunteer firefighting equipment grants), or be tied to existing requirements such as emergency management plans and CWPPs. Data collection could be integrated into ongoing assessment or formal recognition programs such as the Firewise Communities Program, the Fire Adapted Communities Network, or the Ready, Set, Go! Program (FACC 2017, IAFC 2017, NFPA 2017). The result of this integration would be a more spatially consistent and comprehensive dataset of the social conditions that influence wildfire management, and which is a limiting factor in research on landscape-level fire management. Finally, consistent and periodic data collection across a range of communities would eventually allow for research on the "lifecycle" of communities as they learn to and evolve with changing fire dynamics. This type of data is essential to understanding longitudinal change or turnover of populations in the WUI, which often is discussed as a critical influence on landscape dynamics (Spies et al. 2014, Martinuzzi et al. 2015).

Conclusion

Existing research and experience indicates that local context is an important and enduring influence on collective action. The underlying values, beliefs, and relationships with the landscape that often characterize local context might not change quickly, while in other places they may be in a state of dynamic transition. Such local contexts are most likely to serve as opportunities for longer-term action surrounding wildfire management through the iterative co-development of knowledge and trust between collaborating institutions. We would suggest that it is likely easier and more productive to work *with* local context rather than trying to devise discrete ways to change it. Change can then happen over time as stakeholders develop shared ideas about management.

Individuals, organizations, and agencies need to find ways to be part of a community before they can hope to influence its trajectory. Likewise, advancing goals of landscape-level management for wildfire or FACs must account for the socially fragmented nature of the WUI, design tailored management actions that encourage flexible partnerships with distinct "communities," and eventually look for complementary avenues for co-benefit across landownerships, groups, and institutions. Our efforts in this manuscript argue how a holistic view of the Interactional Approach to Adaptive Capacity can help advance systematic ways for studying or implementing variable fire adaptation across diverse communities. Our synthesis of existing literature provides a set of wildfire management approaches that are likely to vary across communities. Finally, we used insights from our first two advancements to propose a set of potential "pathways" for two archetype communities with very different local social contexts.

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