SOCIAL SCIENCE TO SUPPORT WILDFIRE ADAPTATION IN THE U.S. SOUTHWEST

An annotated bibliography of research from 1984-2023

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Cover photo: Sign in a burned area at Mt. Lemmon in southern Arizona, taken after the Bighorn Fire. Photo courtesy of Catrin Edgeley.

A published review of the literature based off this annotated bibliography can be found at the citation below.

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Overview

Social science plays an increasingly critical role in cohesive efforts to adapt to wildfire in the American west. Understanding how communities are adapting to wildfire risk and associated outcomes is foundational for efforts to scale up adaptation efforts to landscape scales, particularly in the southwestern states of Arizona and New Mexico where federal investment in large risk reduction initiatives is growing. This annotated bibliography reviews all existing social science research intended to explore human elements of wildfire in these states, summarizing 65 articles published between 1984 to 2023. The purpose of this bibliography is to help researchers and managers identify relevant social science literature in the Southwest to support wildfire risk reduction planning, management, and recovery efforts.

Approach

Several core online databases, including CAB abstracts, Web of Science, Google Scholar, and Treesearch, formed the basis for this review. Broad search strings such as "U.S. southwest OR Arizona OR New Mexico," "wildfire OR wildland fire OR brush fire OR forest fire," and "social OR human" were combined using advanced search tools in each database to gather candidate publications for review. This process resulted in the identification of 302 unique publications. The following criteria, modified from Toman et al. (2013) and McCaffrey et al. (2013a) to allow comparison with broader wildfire social science trends being observed in the US, were used to screen these candidate publications to determine their suitability for inclusion in this study:

(1) The publication must be focused entirely, or in large part, on the examination of social components of wildfire and its management.
(2) The publication must include primary data collected and analyzed using a social science research method such as interviews, focus groups, or surveys. This focus best captures the populations and contexts studied. Economic studies were excluded because of significant differences in methodologies and data.
(3) The publication must use social data gathered fully or partially in the Southwestern U.S. states of Arizona and New Mexico.
(4) The publication must be a peer or editorially reviewed journal article or book chapter.
(5) The publication must be published or in press by June 2023.

Additional publications identified for consideration were determined via searches conducted in common journals, on prominent researchers, and through review of works cited in initial materials identified through the screening process above.

A total of 65 publications produced between 1984 and 2023 were shortlisted for inclusion in this review (see Table 1 for a full list). These publications generally focused on using social science methods to understand wildfire adaptation across different scales and contexts, with important implications for the establishment and continuity of fire adapted communities – groups of residents, land management, government, and fire professionals who collaborate effectively to plan for, respond to, and recover from wildfire (Paveglio and Edgeley 2020).

Key trends across publications

Initial social science research between the 1980s through the early 2000s prioritized exploration of public attitudes towards forest management techniques that reduced wildfire risk – particularly the use of prescribed fire. The 2000 Cerro Grande Fire in New Mexico and the 2002 Rodeo-Chediski Fire in Arizona introduced regional and national discussion about the role that the public could play in the

wildfire adaptation process, spurring new research that focused on community experiences with fire and their level of engagement in various mitigation actions on private property. The most recent research era, which began around 2010, has broadened the scope of social science research to focus more intentionally on the role of managers in wildfire adaptation, and the contributions and challenges that work at the landscape scale or through collaborative efforts can present to fire-prone places across the Southwest. This annotated bibliography summarizes these research efforts and provides manager implications derived from each study. For a comprehensive literature review that summarizes themes across the articles and chapters summarized below and identifies future research directions for social scientists working to understand wildfire social science in the Southwest, see Edgeley (2023).

Table 1: Publications identified and included in this annotated bibliography.

Full citations for each publication are provided in the reference section.

Publication	General primary data collection method(s)	Safety and evacuation	Wildfire response	Resident mitigation	Partnerships and community engagement	Landscape treatments	Public health	Prevention	Regulations, policy & plans	Infrastructure and business	Recovery	Study location(s)
Cortner et al. 1984	Survey					X						Tucson, AZ
Taylor and Daniel 1984	Survey					X						Tucson, AZ
Brunson and Shindler 2004	Survey					X						Yavapai County, AZ
Muleady-Mecham et al. 2004	Survey					X						Grand Canyon National Park, AZ
Steelman and Kunkel 2004	Interviews, document analysis				X							Santa Fe Watershed, NM; Ruidoso, NM
Carroll et al. 2005	Interviews		X								X	White Mountain region, AZ
Carroll et al. 2006	Interviews		X								X	White Mountain region, AZ
Cohn et al. 2006	Interviews	X										White Mountain region, AZ
Ostergren et al. 2006	Survey					X						North-central Arizona, AZ
Toman et al. 2006	Survey				X							Yavapai County, AZ
Burns et al. 2008	Interviews, focus groups						X				X	Los Alamos, NM, White Mountains, AZ, Mt Lemmon, AZ
Collins 2008a	Interviews, survey, historical analysis			X								White Mountain region, AZ
Collins 2008b	Survey			X								White Mountain region, AZ
Cohn et al. 2008	Interviews			X			X					White Mountain region, AZ
Fleeger 2008	Document analysis, Site visits, Interviews				X				X			Apache-Sitgreaves National Forest, AZ
McCaffrey 2008	Focus groups			X								Flagstaff, AZ
Ostergren et al. 2008	Survey					X						North-central Arizona
Ryan and Hamin 2008	Interviews, focus groups				X	X					X	Los Alamos, NM

Study	Methods									Location
Steelman 2008	Archival document collection, interviews, site visits			X	X					Flagstaff, AZ; Ruidoso, NM
Winter and Cvetkovich 2008	Survey		X							Arizona, New Mexico
Collins 2009	Survey			X				X		White Mountain region, AZ
Collins and Bolin 2009	Survey, property assessments, interviews, participant observation, historical analysis			X						White Mountain region, AZ
Ryan and Hamin 2009	Interviews, focus groups					X			X	Los Alamos, NM
Steelman and DuMond 2009	document analysis, participant interviews, and site visits							X		Apache-Sitgreaves National Forest, AZ
Winter et al. 2009	Focus groups			X				X		Ruidoso, NM
Morehouse et al. 2010	Participatory mapping, interviews			X	X					Catalina-Rincon Mountains, AZ; Huachucas, AZ; Chiricahuas, AZ; Jemez Mountains, NM
Carroll et al. 2011	Interviews								X	White Mountain region, AZ
Bihari et al. 2012	Interviews			X				X		Ruidoso, NM
Owen et al. 2012	Interviews, survey		X							Arizona and New Mexico
McCaffrey et al. 2013	Survey	X								Flagstaff, AZ
Toman et al. 2014	Survey					X				Yavapai County, AZ
Eisenman et al. 2015	Survey						X		X	Apache County, AZ
McCaffrey et al. 2015	Interviews	X								Santa Fe, NM
Nowell and Steelman 2015	Interviews, survey		X							Flagstaff, AZ; Las Vegas, NM
Steelman et al. 2015	Survey	X								Flagstaff, AZ; Las Vegas, NM
Diaz et al. 2016	Survey		X							Flagstaff, AZ; Las Vegas, NM
Colavito 2017	Interviews			X	X					Arizona and New Mexico
Miller et al. 2017	Interviews, document analysis			X	X			X		Flagstaff, AZ
Mottek Lucas et al. 2017	Interviews			X	X			X		White Mountain region, AZ
Urgenson et al. 2017	Interviews			X	X			X		Four Forest Restoration Initiative, AZ; Southern Jemez, NM
Mockrin et al. 2018	Interviews			X				X	X	Wallow, AZ; Monument, AZ
Urgenson et al. 2018	Interviews			X	X					Four Forest Restoration Initiative, AZ; Southern Jemez, NM
Williams and Ishak 2018	Interviews	X					X			Arizona, New Mexico
Zanocco et al. 2018	Survey			X						Yavapai County, AZ
Bradshaw 2019	Interviews, document analysis			X				X		Four Forest Restoration Initiative, AZ
Colavito et al. 2020	Survey			X						Flagstaff, AZ; Tucson, AZ
Edgeley and Burnett 2020	Survey	X					X			Blue Ridge Reservoir area, AZ; Mayer, AZ

Greiner et al. 2020	Interviews		X				X		Arizona and New Mexico
Mockrin et al. 2020	Interviews						X	X	Wallow, AZ; Monument, AZ
Steffey et al. 2020	Interviews, survey			X			X		Prescott, AZ
Tarancón et al. 2020	Survey					X			Mescalero Apache Tribal Lands, NM
Abrams et al. 2021	Interviews					X	X		Kaibab National Forest, AZ
Aslan et al. 2021	Interviews, survey				X	X			Sonoran Desert, AZ
Greiner et al. 2021	Interviews								Tonto National Forest, AZ Santa Fe and Carson National Forests, NM
Plecki et al. 2021	Survey			X					Tucson, AZ
Roos et al. 2021	Interviews			X		X			Jemez Pueblo, NM
Russell et al. 2021	Interviews				X	X	X		Santa Fe, NM
Davis et al. 2022	Interviews		X		X	X			Northern New Mexico
Edgeley and Colavito 2022	Survey	X						X	Flagstaff, AZ
Grimm et al. 2022	Interviews				X				Arizona and New Mexico
Huber-Stearns et al. 2022	Interviews				X	X			Northern New Mexico
Nowell et al. 2022	Interviews		X		X				Arizona
Burnett and Edgeley 2023	Survey			X				X	Flagstaff, AZ
Filmore and Paveglio 2023	Interviews		X						Arizona and New Mexico
Hjerpe et al. 2023	Surveys		X	X				X	Flagstaff, AZ

Annotated bibliography

1980s

Cortner, H. J., Zwolinski, M. J., Carpenter, E. H., and Taylor, J. G. (1984). Public support for fire-management policies. Journal of Forestry, 82(6): 359–361.

A telephone survey of 1,200 residents in Tucson, AZ, was used to determine public support for use of prescribed fire. Respondents indicated a high level of support for prescribed fire use; 84% had heard of this practice, of which 80% approved of its application. The authors attributed this support to recent public information and education programs provided by the Coronado National Forest and Saguaro National Monument (now Saguaro National Park) during periods of prescribed fire implementation. Despite high support, respondents were not familiar with basic fire ecology concepts (e.g., normal fire intensity in pine forests); however, those who reported engaging in fire-focused education or outreach efforts demonstrated higher understandings. This resulted in a positive correlation between education, fire knowledge, and tolerance. Barriers to acceptance of prescribed fire use fell into four categories: (1) concerns regarding risk of escaped fires, (2) concerns that fire causes damage in natural systems; (3) belief that natural systems should not be interfered with due to their complexity; and (4) belief that fire should not be allowed in forests for any reason. The authors suggest that these barriers can be minimized with public education efforts that focus on local forest conditions; for example, introduction of in-survey education resulted in an immediate increase in participant acceptance.

Management implications:
- Residents with higher levels of education and/or knowledge about fire are more likely to be tolerant of fire use.
- Public education efforts should incorporate discussion of local forest conditions to illustrate points in order to increase acceptance of management decisions and techniques.

Taylor, J.G. and Daniel, T.C. (1984). Prescribed fire: public education and perspectives. *Journal of Forestry, 82*(6): 361–365.

The authors conducted a survey of 193 Tucson residents which entailed three phases: (1) rating photos of forest scenes for scenes quality and acceptability for recreation on 10-point scales, each of which were ponderosa stands that had experienced varying fire intensity (unburned, then either a light or severe fire within the past five years at one-year intervals) (2) reviewing one of four educational brochures about fire effects that had varying levels of visual and written information, and (3) a post-test questionnaire that measured both fire knowledge and attitude towards fire and prescribed burning. Perceptions of scenic quality were improved by the presence of light fire but diminished by severe burns. Acceptability ratings for recreation varied by the kind of recreation activity being undertaken; camping and picnicking were most sensitive to fire effects. Educational brochures increased knowledge and tolerance of fire but did not affect ratings of scenic or recreational quality. Support for prescribed fire was high among study participants.

Management implications
- Prescribed burning may improve perceived scenic beauty for up to five years.
- Portions of public land that are frequently used for camping and picnicking may benefit from use of mechanical or hand thinning instead of prescribed fire, as survey participants had lower acceptance of fire impacts in these areas.

- Educational brochures are an effective tool for communicating information about fire effects and should include figures and graphs.

2000s

Brunson, M. W., and Shindler, B. A. (2004). Geographic variation in social acceptability of wildland fuels management in the western United States. *Society and Natural Resources, 17*:661–678.

The authors conducted a mail survey querying social acceptability judgements about reduction of wild land fuel hazards on federal lands in the western United States, with a focus on understanding how contextual factors such as geographic location and respondent characteristics are affect those judgements. Several counties were selected in Arizona, Colorado, Utah, and Oregon; Yavapai County was the focus of the Arizona portion of this study, with 367 surveys delivered to randomly selected addresses, of which 173 were returned (47% response rate). Residents in all four locations demonstrated high agreement for the use of prescribed fire, mechanical vegetation removal, and livestock grazing. However, acceptability and knowledge ranged across all locations, and was tied to landscape contexts (e.g., Yavapai County has more land for livestock grazing than several other study counties and therefore acceptance was higher than in some other surveyed counties. Arizona respondents tended to fall in the middle of the study states in their judgements for most questions, showing general acceptability for fuel treatments. Several notable observations about Arizona respondents in relation to other study states emerged: they were most likely to agree that "humans cause most of the wildfires in this state" (67%), most likely to disagree that "Prescribed fire has little overall effect on the intensity or frequency of wildfires (48%), and least likely to express great or moderate concern about fears for human safety (33%). Approximately 46% of Arizona respondents found prescribed fire a legitimate tool that could be used anywhere or used infrequently in selected areas (45%); acceptance was much higher for livestock grazing, which 70% agreed could be used anywhere. Respondents from all study states were slightly more likely to say that prescribed fire should not be used in populated areas.

Management implications
- While wildfire hazard reduction is a universally acceptable goal, how to achieve this is disputed by residents based on their knowledge and attitudes around the issue.
- Focusing on interacting with local citizens is important for forest planning and management, as they are most affected by the outcomes of these decisions; building trust at this level is likely to increase acceptance of strategies and policies.
- Policies and research based on national-level decisions or studies are unlikely to reflect local social contexts, so should be adapted and applied to the Southwest with local conditions in mind.

Muleady-Mecham, N. E., Lee, M. E. and Burch, B. D. (2004). A public opinion survey on wildland fire in Grand Canyon National Park. *The George Wright Forum, 21*(4):12–21.

A total of 4,618 completed questionnaires were collected from visitors to Grand Canyon National Park's Canyon View Information Plaza on the south rim in 2001. The survey asked for basic socio-demographic information and knowledge and opinions of fire. The authors found that gender, number of children with individual on trip, education level, citizenship (U.S. or not), and number of visits to U.S. national

parks in the individual's lifetime had an effect on how respondents answered the question "If there were a way to prevent all fires in national parks, should they be prevented?" Females who are traveling with more than two children, possess lower education levels (less than a high school diploma), and have made the fewest number of visits to U.S. national parks have a greater chance of responding that all fires should be prevented in national parks than do other individuals; in contrast, males holding graduate degrees, traveling with no children, and who have visited U.S. national parks more than ten times are less likely to agree that all fires should be prevented in national parks. Respondents who opposed all fires represented only 5% of the commenters.

Management implications
- Visitors to Grand Canyon National Park are overwhelmingly in favor of both natural and prescribed fire.
- Visitor outreach on public lands should focus on dispelling misconceptions of fire use and management and responding to specific concerns related to their use.
- Developing educational materials in multiple languages that focus on capturing visitor interest in fire during their first visit may be useful (e.g., a specific brochure handed to visitors during their first visit to a national park or monument; fire-focused introductory interpretive talks).

Steelman, T. A., & Kunkel, G. F. (2004). Effective community responses to wildfire threats: lessons from New Mexico. *Society and Natural Resources*, *17*(8), 679-699.

Interview case studies of decision-making processes in both Ruidoso and the Santa Fe watershed, NM, are compared in this article to understand community responses to wildfire threats. The authors examine the structural responses (e.g., vegetation management programs, land use regulations, structural hardening) and social responses (e.g., organization, planning, and management to help communities determine appropriate structural responses) of these communities. They found that Ruidoso had successfully engaged in both structural and social responses; local organizations and governments developed ordinances with associated enforcement systems, mechanisms for fuels removal on private property, and reporting efforts to interested parties among other efforts. This work was advanced due to strong social responses such as the creation of the Ruidoso Wildland Urban Interface Group and the hiring of a community urban forester. Conversely, Santa Fe established clear structural responses surrounding the Santa Fe Municipal Watershed Project, ranging from the NEPA process to project monitoring, but had difficulty invoking meaningful social responses. This resulted in difficulty implementing the Project due to lack of consistent oversight and inconsistent inclusion of stakeholder insights in the decision-making process. The study concluded with an emphasis on the interconnected nature of structural and social responses after wildfire, and underscored the importance of collaboration as a valuable social response across social contexts.

Management implications
- Appointment of a project coordinator or program manager for large wildland urban interface fuels projects is critical for continuity and cohesion over time
- Inclusion of stakeholder groups as collaborators in the decision-making process can prevent policy and implementation related delays in hazardous fuels reduction efforts on federal land.
- Use of a technical advisory group can help provide scientific guidance and support communication efforts regarding treatment prescriptions and other critical decisions around wildfire mitigation.

- Considerations regarding the social lifespan of a structural response is critical; for example, programs to support vegetation removal on private property must also consider disposal of the resultant materials

Carroll, M. S., Cohn, P. J., Seesholtz, D. N., & Higgins, L. L. (2005). Fire as a galvanizing and fragmenting influence on communities: the case of the Rodeo–Chediski fire. *Society and Natural Resources*, *18*(4), 301-320.

This article presents findings from 75 semi-structured interviews conducted across three northern Arizona "community clusters" directly affected by the 2002 Rodeo–Chediski Fire. The authors sought to examine community galvanization and fragmentation in the aftermath of the fire, which at the time was the largest and most destructive in state history, using structuration theory. Communities galvanized both during and immediately after the fire, sharing both resources and support to aid resident evacuation and subsequent return before later expanding to the coordination of recovery efforts. Fragmenting emerged in several forms, often exacerbating existing conflict between groups after the fire. Tensions were high regarding the Rodeo Fire's management by the Bureau of Indian Affairs, with many interviewees suggesting that more immediate action and calls for external support may have kept the ignition from spreading. This led to cultural tensions in affected communities. A second form of conflict emerged between locals and the federal Type 1 Team; many residents felt their response was delayed and did not use all available suppression resources, as well as ignoring local insights about the landscape, which led to some residents taking suppression matters into their own hands. Conflict also emerged between residents and recovery organizations including FEMA, who many felt had misled them about their eligibility for certain kinds of federal assistance, and the Red Cross, whose perceived lack of organization was a source of trauma for those seeking aid. Finally, conflict emerged between communities over unequal distribution of suppression resources, in addition to tensions within communities caused by varied emotional recovery trajectories related to acceptance of the cause of the fire. Disagreements over forest health further exacerbated tensions around the fire and future vegetation management. The authors concluded that blaming behaviors related to wildfire ignition and management are increasingly common and emerge in varied ways depending on local social context. Power dynamics and the varied agency of actors within a social structure drove conflicts between residents and other entities.

Management implications
- Publicly demonstrating inclusion and understanding of local knowledge during fire suppression is critical to building citizen-agency trust.
- Transparency about the allocation of suppression resources and decision-making processes related to suppression tactics can limit the among of conflict between communities and fire professionals.
- Conflicts that emerge during and after fires are often the product of a pre-existing tension and should be explored (rather than dismissed) in order to improve citizen-agency relationships.

Carroll, M. S., Higgins, L. L., Cohn, P. J., & Burchfield, J. (2006). Community wildfire events as a source of social conflict. *Rural Sociology*, *71*(2), 261-280.

Interview data gathered from six case studies of wildfires in the American West–one of which is the 2002 Rodeo-Chediski Fire in Arizona–were analyzed to examine the specific sources of social conflict in affected communities during and after wildfires. Theories from Weber, Giddens, and Habermas were melded with community interaction theory to provide a context for understanding these conflicts. The

authors identified six issues around which conflict or a strong potential for conflict usually centered: (1) the evacuation process and experience, (2) timeliness and accuracy of information available to affected residents during the wildfires, (3) use or lack of use of local firefighting resources and knowledge by federal firefighting teams, (4) strategies used and authorities exercised by federal firefighting teams, (5) long-standing environmental conflicts concerning the national forests in question, and (6) use and distribution of helping resources during and after wildfire. All six issues were present during and after the Rodeo-Chediski Fire, although those issues did not extent to all actors in the study area. One consistent theme throughout these issues was the impact that decisions perceived as inappropriate or insufficient had on conflict, which typically lead to insider/outsider dynamics in local communities who had a preferred approach to problem solving. Connections between case study observations and social theory hint that conflict after wildfires is in part the consequence of broader social trends and forces at play.

Management implications
- Policy makers should consider how changes to wildfire policy and provision of social services may expand or reduce community agency to act during and after fire events.
- Demonstrating respect for local knowledge and perspectives can help build local capacity for wildfire adaptation and response.
- Most collaboration is focused on pre-fire mitigation; however, expanding collaborative efforts into wildfire response and recovery can build more cohesive social environments between groups.

Cohn, P. J., Carroll, M. S., & Kumagai, Y. (2006). Evacuation behavior during wildfires: results of three case studies. *Western Journal of Applied Forestry*, *21*(1), 39-48.

This article analyzes 183 interviews exploring evacuation behaviors during three wildfires: the 2002 Hayman Fire, CO, the 2000 Cave Gulch/Bucksnort Fires, MT, and the 2002 Rodeo-Chediski Fire, AZ (using the same dataset examined in Carroll et al. 2005, 2006). Two distinct perspectives emerged; those of the evacuees, and those of the public safety officials tasked with decision-making and implementation of evacuations. Across these cases, five distinct stages for the evacuation process emerged: (1) Anticipation, which could begin weeks prior to evacuation and was exacerbated by uncertainty around fire behavior and progression; (2) Warning, which concerned the status of evacuation processes and time available to prepare to leave; (3) Displacement, which was constrained by options for moving livestock or pets; (4) Notification of property condition, during which many had difficulty accessing timely information at the level of detail desired; and (5) Return and recovery, in which post-fire safety concerns emerged and evacuees sought normalcy and routine. Specific observations for the Rodeo-Chediski Fire included challenges getting residents to evacuate, resulting in several arrests. Sheriffs' offices provided escorted tours of the burned area so that evacuees could see the condition of their properties; this was beneficial for some but immensely traumatic for others. Arizona officials also provided re-entry permits for closed areas to ranchers who could then return to feed livestock, which reduced work created for local fire department personnel. The Show Low and Pinetop-Lakeside communities began discussing implementation of a reverse 911 system following the fire. The authors call for additional information to better understand the factors influencing homeowners' decisions to stay or leave during future wildfires and explore the viability of shelter-in-place as an alternative to evacuation.

Management implications

- Most evacuees will not stay in shelters during evacuation; finding ways to gather contact information and disseminate updated announcements more broadly on public platforms is therefore critical to reduce misinformation and stress.
- Evacuation status, location and timing of the wildfire, expected level of impact, and suggested preventative actions are the most commonly sought-after pieces of information by residents in threatened areas.
- Evacuees appreciate public report outs that provide real-time information about fire location relative to their home. This may be a helpful framing for presenting fire suppression activity and progress.
- Use of GIS platforms and satellite imagery to report structure condition and evacuation implementation will reduce uncertainty among residents.

Ostergren, D. M., Lowe, K. A., Abrams, J. B., & Ruther, E. J. (2006). Public perceptions of forest management in north central Arizona: the paradox of demanding more involvement but allowing limits to legal action. *Journal of Forestry*, *104*(7), 375-382.

A random sample of 1,617 addresses sourced from 35 zip codes with ponderosa pine ecosystems in north-central Arizona received a mail survey in 2003 (response rate 43%). The survey sought to understand public perceptions of local forest management; specifically, their opinions on how forest management decisions are made, and the demographic factors that influence these opinions. Respondents generally expressed support for reducing legal barriers to forest restoration; for example, 57% agreed that "the right to sue the government about forestry projects should be temporarily banned." Communication related to forest restoration and management was overwhelmingly important to respondents, with 90% indicating that communication between federal agencies and local communities should improve. If federal agencies are going to initiate restoration projects, 91% of the public wants to be informed and 89% would like to be involved. Demographic characteristics shared relationships with responses to key survey questions. Respondents were less likely to agree that there should be a ban or limit on lawsuits, appeals, and reviews if they had completed higher levels of education. Rural respondents were more likely to support a ban on lawsuits compared to urban respondents. Respondents who were the shortest-term residents were the least critical of current communication efforts. Longer-term residents were more likely to support bypassing environmental review requirements, more likely to say that communication between agencies and communities needs to improve, and more likely to believe that national forest management should generate income for people. The authors uncover an apparent paradox: members of the public in north-central Arizona want to expedite the pace of forest restoration by limiting legal interventions that may slow these processes, while simultaneously demanding to be informed and involved in the planning process, which typically extends the decision-making process.

Management implications
- An overwhelming majority of residents in north-central Arizona are interested in participation and communication related to forest management, although survey findings suggest that engagement may be higher outside of formalized legal processes such as NEPA.
- Public understandings of being "informed" about or "involved" in agency decision-making exist along a spectrum; individuals differ in their understandings of these terms. As a result, there is a need to offer multiple levels or formats for engagement in these processes.
- Arizonans vary significantly in their opinions on forest service decision making depending on factors such as education, age, and residency tenure; this suggests that managers should take different approaches to engaging the public rather than a one-size-fits-all approach.

- Local fire departments are a trusted entity for resident fire education in north-central Arizona.

Toman, E., Shindler, B., & Brunson, M. (2006). Fire and fuel management communication strategies: citizen evaluations of agency outreach activities. *Society and Natural Resources*, *19*(4), 321-336.

Principles of adult learning theory were applied to better understand citizen reactions to eleven communication methods commonly used by federal land management agencies. The authors survey residents in four states–Arizona, Colorado, Oregon, and Utah–to examine unidirectional (one way communication, such as brochures and television ad campaigns) and interactive (face-to-face efforts such as field trips and public meetings) communication methods. Arizona respondents were based in Yavapai County (173 responses for a 47% response rate; this article uses the same dataset as Brunson and Shindler 2004). Arizona respondents were far more likely to find unidirectional communication methods helpful compared to others study states. They also were far less likely to find conversations with agency employees helpful, although this interactive method was still relatively positively viewed (70% found conversations trustworthy, compared with 90% of Colorado respondents). Respondents from all study states indicated low trustworthiness and helpfulness in government public meetings; the authors suggest that this may be because meetings are often perceived as uni-directional communication efforts when opportunities for audience input are not present. Overall, responses were relatively consistent across study states, suggesting that certain program formats appeal to respondents regardless of their location. Despite this, they argue against a one-size-fits-all solution, highlighting the need for messaging that reflects local contexts.

Management implications
- Interactive communication methods are increasingly viewed as trustworthy and helpful by residents
- Taking a problem-centered approach that places local issues at the heart of communication messaging can build stronger trust and engagement with fire-related management issues. This is most successfully achieved through interactive methods
- public meetings should be structured to ensure audience input and support two-way conversations in order to build trust.

Burns, M.R., Taylor, J.G., and Hogan, J.T. (2008). *Integrative healing: the importance of community collaboration in postfire recovery and prefire planning*. **P81-97 in Wildfire risk: Human perceptions and management implications, Martin W.E., Raish C., Kent B. (eds.). Resources for the Future Press, Washington, DC.**

Collaborative recovery efforts are increasingly prominent after wildfires in the U.S. The authors share themes from five case studies of wildfire recovery using interviews, focus groups, and literature reviews, including three Southwestern Fires: the 2002 Cerro Grande Fire, NM, 2002 Rodeo-Chediski Fire, AZ, and the 2003 Aspen Fire, AZ. Each of these efforts revolved around landscape recovery in the corresponding burn scar to support physical, social, and psychological healing. After Cerro Grande, trusted community leaders established the Volunteer Task Force (VTF), which drew more than 500 volunteers and school groups to work on forest and landscape recovery activities such as tree planting and trail reconstruction. Volunteers described the VTF as satisfying a need to connect with the environment and engage in landscape recovery as part of their personal recovery processes. Once the Rodeo-Chediski Fire was contained, VTF leaders from Los Alamos traveled to the area to support recovery and support post-fire knowledge exchange. Within five days, a similar effort had been established, drawing 200 volunteers to the first event. The Rodeo-Chediski VTF effort was integrated with Burned Area Emergency Response

team efforts and leveraged pre-existing recreation-oriented groups such as hiking and ATV clubs. Recovery efforts after the Aspen Fire were more complex; while Los Alamos' VTF visited once again, a collaborative group did not emerge and the terrain was far more complex, resulting in area closures that prevented volunteer access. Volunteers were most enthusiastic about working while fire suppression activities were ongoing, creating safety issues and challenging the feasibility of restoration work at that time. Local support for volunteer collaboration was limited, and largely consisted of established groups that already had liability insurance. This lack of cohesion meant that opportunities for engagement of the general public were much scarcer than after Cerro Grande and Rodeo-Chediski.

Management implications

- Collaborative efforts to support landscape recovery after wildfire can play an important role in public healing and personal recovery processes in Southwestern communities.
- Collaborative efforts after fire are most successful when they leverage existing interest groups and local leadership, entail partnerships with agencies, and are initiated after fire suppression is complete.
- Engaging the public in post-fire restoration activities is an effective technique for education and outreach to communicate about forest health and private property mitigation techniques.

Collins T. (2008a). The political ecology of hazard vulnerability: marginalization, facilitation and the production of differential risk to urban wildfires in Arizona's White Mountains. *Journal of Political Ecology, 15*(1), 21-43.

This article provides an examination of wildfire vulnerability and risk perceptions across White Mountains communities–Linden, Show Low, Lakeside, Pinetop, McNary, and Hon-dah, Arizona–through a political ecology lens. The author uses mixed methods, including survey data from 493 households, semi structured interviews with 33 households, participant observation, and historical and archival analysis. Shifting fire regimes and population growth in northern Arizona drove the emergence of sharper inequities, including the establishment of country clubs, increase in second home ownership, and a broader economic shift from timber to tourism. Institutional structures were the most important influence on differential household risk; for example, real estate and planning commissions might downplay hazard vulnerability of a property for their own benefit. Type of development (mobile home, cabin, condo, etc.) was another significant contributor to varied risk within communities. Lastly, ideologies and values of residents (such as advocacy for private property rights) influenced resident perceptions of different kinds of hazard mitigation strategies, regardless of their effectiveness. Together, these factors restrict the options a household has for risk reduction. Data collection across communities allowed for the development of a typology of two kinds of residential landscapes–livelihood and lifestyle–which are characterized by varying degrees of livelihood security, environmental values, and hazard exposure. Lifestyle landscapes tend to be comprised of more affluent residents who rely on institutions to protect them, whereas livelihood landscapes are more independent and vulnerable to economic variability (as well as more likely to be marginalized in conversations about and actions to address hazard risk).

Management implications
- Vulnerability to wildfire is comprised of a constellation of considerations; studies that only focus on demographic data to characterize a household's vulnerability are not reliable.
- The organizations and entities that communities interact with shape their views of wildfire risk, affecting their willingness to engage in mitigation.

- Community vulnerability to wildfire can change and evolve over time as a result of social and ecological shifts.

Collins, T. (2008b). What Influences Hazard Mitigation? Household Decision Making About Wildfire Risks in Arizona's White Mountains. *The Professional Geographer, 60*(4), 508–526.

Engaging residents in proactive mitigation on private property remains a focal task for fire professionals. The author examines survey responses from 493 households in Show Low, Lakeside, and Pinetop, Arizona (the same dataset used in Collins 2008a and Collins 2009) following the Rodeo-Chediski Fire to explore six factors that influence implementation of risk reduction activities: hazard perceptions, ecological knowledge, amenity values, institutional incentives, social vulnerability, and place dependency. Analysis revealed that there is no relationship between respondents' risk perceptions and their decisions to mitigate. However, relationships to exist between mitigation actions and property value, full-time residency, length of residency, retiree status, and household income among other variables. Place dependency emerged as a catalyst for mitigation. Survey analysis suggests that lower income, renter, and working households are less likely to engage in mitigation, reflecting drivers of underlying vulnerability. These findings indicate that public education alone is not a driver of mitigation uptake.

Management implications
- Barriers such as financial means and time available to dedicate to mitigation likely have a significant impact on a household's ability to perform mitigation activities; programs to support mitigation should acknowledge and address this inequity.
- Wildfire protection programs should not rely solely on public education to encourage private property mitigation; use of cost share programs and access to resources that alleviate the burden of mitigation can support a more inclusive and equitable approach to mitigation across varying household contexts.
- Interventions to engage residents in mitigation activities should seek to reduce or eradicate any negative influence that real estate, local government planning, and residential property management organizations like homeowners associations sometimes create.

Cohn, P., Williams, D.R., and Carroll, M.S. (2008). *Wildland-urban interface residents' views on risk and attribution*. **P23–43 in Wildfire risk: Human perceptions and management implications, Martin W., Raish C., Kents B. (eds.). Resources for the Future Press, Washington, DC.**

This chapter reviews emergent themes related to wildfire risk perceptions from 316 interviews across six community case studies, including the Rodeo-Chediski Fire (using the same dataset from Carrol et al 2005, 2006; Cohn et al. 2006). Many interviewees' perceptions of wildfire risk had evolved after their recent experiences; most interviewees affected by the Rodeo-Chediski Fire believed that another wildfire of a similar magnitude would occur in the future, although individuals from the Heber-Overgaard-Forest Lakes community cluster were more inclined to believe this was a one in one-hundred-year event. Examination of fire cause revealed a strong belief that forest management by federal agencies was not aggressive enough and had been restricted by litigation brought forward by environmental groups; this was particularly true in historically resource-dependent communities like Heber-Overgaard-Forest Lakes and Clay Springs-Linden-Pinedale. Concerns related to wilderness designation as a factor restricting active forest management also emerged in Arizona. These conditions, in addition to antecedent conditions such as topography and winds, let Arizona interviewees to conclude that it was just a matter of time before a large fire event like the Rodeo-Chediski would occur.

Arizona interviewees also tended to be critical of suppression decision making and questioned whether tactics prioritized some communities (i.e., Show Low-Pinetop-Lakeside) while "sacrificing" others (i.e., Heber-Overgaard-Forest Lakes). Blaming behaviors for fire ignition and related damages were most likely in communities that had sustained significant loss. The Rodeo-Chediski Fire served as a "wake-up call" for many. This chapter highlights variations across fires, indicating that discussions and approaches to wildfire risk reduction and perceptions of fire responsibility are likely to differ based on local social and ecological contexts.

Management implications
- There appears to be a disconnect between the extent of property damage and (lack of) mitigation actions for many residents after fire. Describing mitigation activities in terms of the risks they help reduce (e.g., fine mesh vents prevent embers accessing attics or lofts) can help demonstrate specific benefits to encourage uptake.
- There is often a greater interest in fire risk mitigation information immediately after a wildfire.
- There is widespread agreement among fire-affected residents that government entities should pay for planning and education related to wildfire, while residents should be responsible for costs on private property.

Fleeger, W. E. (2008). Collaborating for success: community wildfire protection planning in the Arizona White Mountains. *Journal of Forestry*, *106*(2), 78-82.

The Sitgreaves Community Wildfire Protection Plan (CWPP) was completed in 2004, and includes the communities of Vernon, McNary, Hon Dah, Pinetop-Lakeside, Show Low, Linden, Clay Springs-Pinedale, Aripine, Heber-Obergaard, and Forest Lakes. It was spearheaded by the Natural Resources Working Group (NRWG), a regional collaborative with an interest in fuel treatments and fire management. Facilitation of two community action groups provided key public involvement opportunities. The author combined document analysis, site visits, and interviews to identify five key factors contributing to the success of the Sitgreaves CWPP: (1) Strong commitment to the collaborative process across all study participants; (2) the ability to capitalize on existing working relationships built by the NRWG; (3) US Forest Service support and participation that promoted a "communities first" approach to the CWPP; (4) high awareness of fire risk following the 2022 Rodeo-Chediski and 2003 Kinishiba fires; and (5) high participant understanding of the interconnectivity between forests and communities in the CWPP area. The article concludes with an emphasis on the importance of engaging all levels of government and community stakeholders in wildfire risk reduction processes.

Management implications
- Development of CWPPs that build on pre-existing collaborations, groups, or relationships can accelerate plan development while prioritizing shared values
- Agencies can play a key role in enabling communities to plan for wildfire risk reduction by providing technical expertise

McCaffrey, S. (2008). *Understanding public perspectives of wildfire risk.* P11–22 in Wildfire risk: Human perceptions and management implications, Martin W.E., Raish C., Kent B. (eds.). Resources for the Future Press, Washington, DC.

Fifteen focus groups were held with residents across three western locations, one of which was Flagstaff, AZ, to investigate varied understandings of wildfire risk. Participants described wildfire risk as high, tying this to factors including environmental conditions and ignition sources before making connections to values at risk and the impacts of these potential losses. In Flagstaff, perceptions of risk

also were tied to local environmental contexts such as wind that would exacerbate the likelihood of loss and uncontrolled fire spread. Participants felt that messaging efforts were not accurate, either under or overstating wildfire risk as they perceived it; roadside signage indicating risk levels was most commonly discussed and appeared to hold interest for residents because they were managed by trusted professionals. Flagstaff participants also demonstrated self-selection behaviors related to risk driven by emotional response–specifically, those who chose to live in the broader vicinity rather than within city limits–explaining that they had actively sought properties within the local landscape that they felt had lower wildfire risk. For those within the city limits, perceived benefits outweighed the risks. This study highlights the subtleties of wildfire risk perceptions, and emphasizes the complex web of social and environmental factors that contribute to resident constructions of this risk.

Management implications

- Both logic and emotions play a significant role in resident perceptions of their property's wildfire risk.
- Use of signage to communicate wildfire risk is most effective if the information source is trusted by the intended audience.
- Messaging related to wildfire risk should draw upon multiple drivers of risk rather than focusing on one source, cause, or consequence.

Ostergren, D. M., Abrams, J. B., & Lowe, K. A. (2008). Fire in the forest: public perceptions of ecological restoration in north-central Arizona. *Ecological Restoration*, *26*(1), 51-60.

Use of fire as a tool for forest restoration and management has gained significant traction in the Southwestern U.S. The authors review findings from a survey of 693 randomly selected properties across 35 zip codes overlaid on a vegetation map identifying ponderosa pine (response rate 47%; this study uses the same dataset as Ostergren et al. 2004). The majority (76.5%) of respondents identified both prescribed fire and thinning as forest restoration activities. Respondents supported forest restoration for various reasons, the most common of which were that they liked forests or field that they had a "duty to care for the natural world." Only 31.7% agreed that the purpose of forest restoration was to protect humans from fire, a finding the authors found surprising given the recency of the Rodeo-Chediski Fire. Approximately 87.1% of respondents agreed that the purpose of forest restoration should be to promote working ecosystems. Respondents were divided in their support for the partial removal of ponderosa pine trees prior to reintroduction of fire. Support for continued human intervention in forest health was significant; 61.5% disagreed that thinning should only occur once in a forest, and 50.8% disagreed that forests should evolve without intervention. Level of education was a significant factor in respondent support for forest management. Survey responses suggest that residents in north-central Arizona understand restoration to be active management that includes but is not limited to wildfire risk reduction.

Management implications

- North-central Arizona residents' connection to forests and perceived obligation as caretakers of these ecosystems drives their support for forest restoration; this may be a valuable tool for framing messaging around restoration activities like prescribed fire.
- Rural residents in north-central Arizona are more likely to support continued active management; however, they also are less likely to support the removal of trees, suggesting that aesthetic considerations will be critical to consider in these areas.
- Public perceptions and opinion in north-central Arizona have shifted to include a basic understanding of restoration principles and goals.

Ryan, R. L., & Hamin, E. (2008). Wildfires, communities, and agencies: stakeholders' perceptions of postfire forest restoration and rehabilitation. Journal of Forestry, 106(7), 370-379.

Southwestern communities are increasingly interested in observing and learning about post-fire restoration and rehabilitation. This article examines stakeholder perceptions of these processes in communities affected by three fires, including Los Alamos, NM, which was affected by the 2000 Cerro Grande Fire. A total of 45 key informant interviews and six focus groups (two per study area; in Los Alamos, this consisted of one with local residents and another with recreationalists and volunteers engaged in post-fire restoration work) are discussed. For Los Alamos participants, the need for post-fire restoration depended on the location of the fire; however, most believed that government agencies held responsibility for mitigating consequences to communities (such as post fire flood risk) associated with the fire. This belief was driven by a perception of low existing forest health and personal experiences with flooding and mudslides, leading to a preference for prioritization of wildland-urban interface-focused restoration and mitigation efforts above backcountry areas. Additional preferences emerged for prioritized restoration of "special places" that represented shared value within the community (e.g., trails) and supported emotional healing after traumatic wildfire experiences. Most participants felt that collaborations between the public and land management agencies to engage post-fire restoration work build stronger relationships; however, one notable exception was Native American pueblos, who described larger cross-boundary reseeding efforts as disregarding their cultural traditions and land management knowledge. Education and outreach efforts from the US Forest Service to explain the purpose and process of post-fire restoration activities were in high demand. Four vectors emerge that can be used to help determine the level of need for post-fire agency-community engagement: Fire extent, community and agency relations, place involvement, and resource dependence.

Management implications

- Communities affected by fire are generally enthusiastic about being engaged in post-fire planning and restoration activities; inclusion of the public in agency efforts can build trust.
- Cross boundary or large-scale post-fire rehabilitation projects (e.g., reseeding) that include tribal lands should incorporate cultural considerations and Indigenous knowledge into the planning and implementation process.
- Public interest in information about federal restoration efforts, as well as actions that private landowners can take on their own property, is high after wildfires.
- Prioritizing volunteer engagement in post-fire restoration at "special places" – i.e., locations that are of significant importance to the community – can support emotional healing among impacted groups.

Steelman, T. (2008). *Addressing the mitigation paradox at the community level*. P64-80 in Wildfire risk: Human perceptions and management implications, Martin W.E., Raish C., Kent B. (eds.). Resources for the Future Press, Washington, DC.

When wildfire risk to a community is perceived as much higher than risk to individual properties, community-level mitigation becomes prioritized and incentivized over individual property owner actions–a problem often referred to as the "wildfire mitigation paradox." Data gathered from archival document collection, interviews, and site visits in Flagstaff, AZ and Ruidoso, NM in 2002 were analyzed in this study to investigate this phenomenon. Flagstaff has a constellation of institutional arrangements ranging from its own Fuel Management Division within the City's Fire Department, establishment of mitigation-oriented building codes and stewardship plans, and cost-share programs in partnership with local and state organizations. This was paired with informational efforts such as demonstration projects,

broad outreach and education programs including Firewise, and targeted campaigns to engage property owners in property risk assessments. A pattern of shared responsibility emerged, with the establishment of many groups such as the Ponderosa Fire Advisory Council, a consortium of local fire agencies, and the Greater Flagstaff Forest Partnership, an alliance of many organizations focused on forest restoration. Ruidoso shares a proactive pattern of mitigation efforts with Flagstaff, largely emerging from the establishment of the Ruidoso Wildland Urban Interface Group (RWUIG) following ongoing concerns about risk (see Steelman and Kunkel 2004 for more detail). An urban forester was hired for Ruidoso, later positioned within the new Forestry Department established in 2003, who oversaw property assessments. Ordinances emerged for tree removal and treatments through community-led groups, and cost-share programs emerged at the state level. A coordinated slash and debris removal program also emerged via local government, which entailed the purchase of machinery to minimize barriers to participation. Informational efforts included Firewise workshops, use of a FEMA grant to produce and disseminate educational materials related to evacuation and fire awareness, development of a neighborhood fire watch program, and outreach in local schools. Ruidoso and the Forest Service coordinated on cross-boundary fuels management projects, and RWUIG coordinated other collaborations, allowing for the establishment of shared responsibility. Both study areas benefited from three-pronged approaches that included improvement of institutional arrangements, informing the community, and sharing responsibility for risk to begin altering risk-benefit ratios at the property and community levels.

Management implications
- Use of regulations for fuels management on private property should consider whether residents have the means by which to complete required actions. Financial limitations and skill or equipment related barriers are prominent, meaning that assistance or incentivization may increase completion rates.
- Mitigation programs should take into account personal beliefs, societal norms, and culture of their respective communities in order to be effective.
- Agency-community coordination across boundaries can demonstrate willingness to undertake mitigation efforts, increasing local perceptions of benefits related to risk reduction.
- Holistic risk reduction must include both landscape/community level efforts and work undertaken individually on private property in order to support successful fire adaptation.

Winter, P.L., and Cvetkovich, G.T. (2008). *Diversity in Southwesterners' views of Forest Service fire management.* **pp. 156-170 in Wildfire risk: Human perceptions and management implications, Martin W.E., Raish C., Kent B. (eds.). Resources for the Future Press, Washington, DC.**

Attitudes towards wildfires and their management can often affect or exacerbate relationships between communities and land management agencies. A telephone survey of residents in Arizona (n = 402), California (n = 606), Colorado (n = 402), and New Mexico (n = 401) was conducted using regional planning divisions to sample participants, with the goal of better understanding public perceptions of the Forest Service relative to fire management. Respondents were asked to respond to each question using a Likert scale from 1 (lowest) to 8 (highest). Most respondents were concerned about wildfire in their state (mean = 6.7), with the highest levels of concern emerging among Native American/First Nations and Latino/Hispanic respondents. The average respondent rated their knowledge about fire in their state as modest (mean = 5.3). The majority of respondents felt their personal values, goals, and views about fire aligned with those of the Forest Service, resulting in an average trust response of 6.3. Respondents identifying as female were more likely to express higher levels of trust, while white/Caucasian and multi-racial respondents had lower levels of trust than other ethnic or racial

groups. Agreement on statements related to the need for fire suppression varied significantly between ethnic/racial groups; for example, the statement "all fires must be extinguished regardless of cost" was agreed with by 55.5% of Black/African America, 53.0% of Latino/Hispanic, 48.2% of Native America/First Nation, 36.4% of Asian American/Pacific Islanders, and 15.7% of white/Caucasian respondents. Respondents were more likely to agree with letting fires take their course when structures were protected.

Management implications

- Each ethnic/racial group in the Southwest will likely respond differently to the same wildfire management strategy.
- The increasingly diverse range of ethnicities and races in the Southwest means that opinions on fire management and the Forest Service may continue to fragment.
- Establishing and maintaining trust across varied ethnic/racial groups can help build support for unpopular or unfamiliar fire management approaches.
- Lower knowledge of wildfire tends to result in higher levels of trust in the Forest Service.

Collins, T. W. (2009). Influences on wildfire hazard exposure in Arizona's high country. *Society and Natural Resources*, *22*(3), 211-229.

This article presents a conceptual model of influences on household wildfire hazard exposure based on eight contributing factors: Hazard perception, ecological knowledge, amenity values, fire insurance, social vulnerability, place dependency, self-protection, and housing contextual factors. The model was designed using the results of a household survey of four Arizona White Mountains communities: Linden, Show Low, Lakeside, and Pinetop (n = 493). Data analysis found positive relationships between hazard exposure and: perceptions of wildfire hazard, environmental amenities, reference for privacy, and certain residential settings. Negative correlations emerged between hazard exposure and: retirement status, full time residency, forest dependency, length of residence, the cash value of dwellings, age of dwelling, self-protection variables, prevention, and mitigation. Respondent agreement with the statement "I would not live here without fire insurance" is positively corelated with hazard exposure and controls for other variables in a multivariate analysis. Social vulnerability was found to have little to no influence on household hazard exposure. Longer term and full-time residents occupied less hazardous properties compared to newcomers and part time residents. The author concludes that cognition of hazards plays a significant role in household-level decision-making about wildfire, and that hazard exposure is broadly influenced by a constellation of factors that seem more closely connected to property characteristics than social factors. Lastly, findings suggest that efforts to reduce wildfire hazard might hinge more on incorporating safety considerations into the residential development process than individual property level mitigations alone.

Management implications

- Promoting the aesthetic values and potential for increased property value associated with property fire safety may motivate residents to engage in mitigation activities on private property.
- Legally mandating a property-specific disclosure statement about wildfire hazards during real estate transactions in fire-prone areas may increase engagement in mitigation activities undertaken by new residents.
- Communication with property owners should encourage uptake of a range of adaptation strategies to overcome inaction, particularly inaction motivated by the perception that fire insurance is an adequate substitute for hazard reduction

Collins, T. W., & Bolin, B. (2009). Situating hazard vulnerability: people's negotiations with wildfire environments in the US Southwest. *Environmental Management*, *44*, 441-455.

The authors implement a multimethod study to establish greater understanding of the cross-scale influences that produce hazard vulnerability across particular groups in the White Mountains region of Arizona. Study communities included Linden, Show Low, Lakeside, Pinetop, McNary, and Hon-dah, where survey data and property hazard assessments were gathered from 493 households, in addition to semi structured interviews with 33 households, participant observation, and historical and archival analysis. Despite the then-recent Rodeo-Chediski Fire, few seasonal interviewees had taken action to reduce wildfire hazards in their community, with many citing these actions as detracting from the features that drew them to live in the area (e.g., privacy, aesthetics, climate, "natural" conditions); conversely, this place attachment motivated action among full-time residents. Some households described purchasing insurance as a substitute for conducting mitigation activities to protect their property; however, when asked if they would live in the area without fire insurance, only long-time local residents agreed. Others felt that a lack of insurance access would motivate them to do more mitigation work around their home or had recently begun to conduct mitigation efforts as a result of incentivization from their insurance company or cost-shares from other entities (although others felt that incentives were not substantial enough to justify the work). The costs and required resources associated with many of these actions exacerbated social vulnerability within and between communities. Some homes were "red flagged" as indefensible during the Rodeo-Chediski Fire, which motivated others to begin work. As a result of these varied motivators and conditions, wildfire hazard reduction became a decision based on the costs and benefits for each household. The authors conclude that land use change has amplified hazard vulnerability in the White mountains as priorities shift from extractive industries to an amenity economy.

Management implications
- Human responses to wildfire risk are ever evolving and a product of their personal and local contexts
- Not all residents who do not mitigate their property do so by choice or naivety. Many do not have the means by which to achieve these actions, so discussions should focus on resources and assistance to support more equitable opportunities for risk mitigation.
- Framing to motivate action by both residents and the amenity industry should prioritize socially and ecologically responsible ways of consuming nature.

Ryan, R. L., & Hamin, E. (2009). Wildland—Urban Interface Communities' Response to Post-Fire Salvage Logging. *Western Journal of Applied Forestry*, *24*(1), 36-41.

Salvage logging is often considered controversial and receives pushback from environmental groups; however, it is not as clear how WUI residents perceive this practice. The authors investigate this research gap via an exploratory study of three WUI communities that had recently experienced wildfires, focusing on understanding support or opposition for various post-fire treatments. Los Alamos, NM, was one of the study communities due to the then-recent Cerro Grande Fire. The authors conducted 45 key informant interviews across all locations, before holding two focus groups in each community (for more analysis of this data set, see Ryan and Hamin 2008). Support for salvage logging was unexpectedly high; of the 100 study participants, only seven explicitly voiced opposition. For most, support was conditional on the use of ecologically appropriate, low impact practices to conduct this

activity. Many felt that leaving these trees to rot was "wasteful" if instead some economic benefit could be yielded, preferably with profit being invested in further forest restoration. Consensus also emerged that aesthetically, burned forests were not attractive, motivating greater demand for government agencies to rehabilitate these areas. Selective salvage logging that left snags for ecological benefit was preferable to clear cut areas. Los Alamos participants were particularly interested in the impact salvage logging might have for improved recreation safety on public lands. USFS was considered to have appropriate expertise to conduct salvage logging, although some worried that their interests aligned too closely with the logging industry's.

Management implications
- Public trust can be gained or strengthened by demonstrating that the focus of this work is on ecological benefit rather than profit.
- Safe recreation access is a notable driver of public support for salvage logging in the Southwest.
- Public support for salvage logging can also be increased by demonstrating how this activity produces direct benefits to the local community via reinvestment into post-fire restoration or fire prevention and risk mitigation activities.

Steelman, T.A and DuMond, M.E. (2009). Serving the common interest in US forest policy: a case study of the Healthy Forests Restoration Act. *Environmental Management*, *43*, 396-410.

The Healthy Forests Restoration Act (HFRA) was passed in 2003, partially with the intent to unify different groups engaged in decision-making about public lands and hazardous fuels reduction through common interests. This study explores common interests across three Environmental Assessments (EA) for HFRA WUI fuel reduction projects on the Apache-Sitgreaves National Forest, AZ: Greer, Nutrioso, and Eagar South. Research methods included document analysis, participant interviews (n=21), and site visits. Several criteria can be used to assess whether a decision-making process supports the common interest, two of which this manuscript focuses on: procedural (is it fair – i.e., inclusive, representative, interactive, and transparent?) and substantive (are stakeholder concerns valid, adequately addressed, and is the final outcome supported). The Greer EA was substantively robust and procedurally mixed; interviewees felt the process was inclusive, had reasonable concerns, and supported the outcome, but had critiques about the process and absence of representation. The Nutrioso EA yielded the same criteria outcomes, but for different reasons in some instances; there was a greater level of interaction with the Forest Service, although how public comments and concerns were incorporated into the final decision was not always perceived as transparent. Participant concerns were valid and aligned with the area CWPP. The Eagar South EA was substantively weak and procedurally mixed. Some interviewees did not agree with the process for this EA and raised concerns about its transparency, opportunities for inclusion and engagement were low. Environmentalists' concerns were quickly dismissed by the Forest Service, yet could have been easily addressed via site visits. The result was objection towards the final outcome, as the Forest Service appeared to prioritize its own interests above the common interest. The authors conclude that HFRA has not markedly changed public involvement opportunities for forest management decisions.

Management implications
- Environmental groups in the Southwest are more likely to participate in formal processes like NEPA instead of more organic processes like CWPPs because they can leverage administrative and legal means to ensure their concerns are heard.
- HFRA significantly reduced the amount of time spent on NEPA processes for forest health and hazardous fuels projects.

- Placing priority on addressing valid concerns raised via the public involvement process (e.g., prescription justification, wildlife impacts) as early as possible can minimize delays in the NEPA process.

Winter, G., McCaffrey, S., & Vogt, C. A. (2009). The role of community policies in defensible space compliance. *Forest Policy and Economics*, *11*(8), 570-578.

Growing interest in local level mechanisms to motivate homeowner wildfire risk mitigation includes the provision of incentives and the introduction of new or additional regulations. The authors apply the theory of reasoned action to data collected at focus groups with community members from three communities including Ruidoso, NM. Focus group participants were most accepting of local policies they saw as fair and integrated within a broadly comprehensive approach. Ruidoso participants underscored the need for collective action, indicating that work on private property had a limited affect if adjacent public lands were not also managed. Resistance to regulatory approaches was present across all three study sites, with a preference for voluntary actions and programs; however, many participants recognized that in some contexts, regulation might be the only path forward to ensure action. Ruidoso residents saw regulation as necessary and a legitimate use of power relative to community wildfire risk. In these instances, participants expected the enforcing entity to provide the resources and information necessary to meet these requirements, ideally through consultation programs with local experts and mail packets. Compliance with such programs would depend on a number of factors, including aesthetic and place attachment considerations, neighborhood norms, compliance feasibility (particularly from a financial perspective), the extent to which that policy is enforced, and concern about impacts to soil erosion in the case of Ruidoso. Full time residents believed that seasonal residents and vacationers were disproportionately responsible for ignition risk and noncompliance with vegetation management practices – regardless of whether these perceptions were accurate – and felt that communication and messaging should target these populations. Overall, the authors found residents more amenable to regulation than previous research and experience might suggest.

Management implications
- Acceptance of local-level policy – particularly mandatory and regulatory policies – depends on the attributes it has. Residents are often concerned with fairness of the policy and equitable enforcement, recognizing the need for all parties to contribute to risk reduction.
- Provision of assistance, resources, and support from enforcing agencies may influence increased community support for regulation.

2010s

Morehouse, B. J., O'Brien, S., Christopherson, G., & Johnson, P. (2010). Integrating values and risk perceptions into a decision support system. *International Journal of Wildland Fire*, *19*(1), 123-136.

Integration of public values into place-based decision support tools and technologies offers a useful opportunity for building stronger relationships between citizens and fire professionals. The authors introduce Fire–Climate–Society version 1(FSC-1), an online decision support tool that allows exploration of scenarios and varied weighting of different social and ecological model components, created using data from four mountain ranges of the Southwest. Part of this effort entailed collecting data from 117 individuals living or working in these areas: 36 from the Catalina-Rincon Mountains, 21 from the Huachucas, and 20 from the Chiricahuas, all in Arizona, and 40 from the Jemez Mountains in New

Mexico. Participants were asked to (1) draw areas that held different values to them on a map of their local mountain range that were later digitized for inclusion in FCS-1, and (2) engage in a semi-structured interview about their mapping efforts. Hiking, wildlife viewing, sight-seeing and picnicking each accounted for 10% or more of respondents' use values. For areas participants did not use, intangible attributes such as beauty and isolation accounted for 41% of assigned values, followed by ecosystem and wildlife habitat value for a further 28%. Respondents predominantly assigned areas as "at risk" based on fuel characteristics (26%), policy, management, or governance issues (25%) or likelihood of ignition (15%). Agency employees, environmental advocates, business owners, and recreationists gave very similar answers about what they valued most within their local landscapes. Mount Lemmon in the Catalinas and the Rincon Mountains emerged as an area of significant value as well as an area of concern for fire risk, the former likely due to high recreation appeal and ease of access in addition to high visibility across the surrounding area.

Management implications
- Public lands that are accessible for recreation or other activities are typically valued far more than more remote or inaccessible areas by citizens.
- Participatory mapping activities can identify commonalities in places of value and importance across disparate and often conflicting groups, serving as a foundation for shared understanding around wildfire and forest management issues.

Carroll, M.S., Paveglio, T., Jakes, P. J., & Higgins, L. L. (2011). Nontribal Community Recovery from Wildfire Five Years Later: The Case of the Rodeo–Chediski Fire. *Society and Natural Resources*, *24*(7), 672-687.

This article presents a 2007 restudy of communities affected by the Rodeo-Chediski fire after five years, following on from prior studies by several of the authors (see: Carroll et al. 2005, 2006; Cohn et al. 2006, 2008). Data collection efforts during this restudy focused on exploring the longevity of conflict and cohesion in post-fire environments, resulting in 46 interviews across the White Mountains, AZ that were then analyzed through the lens of structuration theory. Galvanization had continued long after the fire, but had transformed from "coming together" to local community action such as grant writing to overcome some of the shared challenges that had emerged over time. Broad support for forest stewardship had also emerged based on shared local interests, aligning with the arrival of HFRA projects shortly after the fire. Three sources of fragmentation still remained: (1) federal versus local conflict over how the fire was fought; (2) environmental conflict concerning forest conditions and management and the relationship to past and future fire risk for the communities; and (3) cultural conflict between some local whites and the White Mountain Apache tribe on whose reservation lands both fire starts occurred. These conflicts had become part of community identity in some instances, disconnected from the original cause and now ingrained within local culture as a "given." Several implications emerged for future wildfire events in the White Mountains. Residents were increasingly interested in staying to defend their property during future fires as a result of negative experiences with evacuation during the Rodeo-Chediski Fire, but had yet to take action on their property to make this a feasible option. Officials also observed a gap between discussion of future fires and actions to address that risk. However, the fire had opened avenues for additional training and resources at the agency level, as well as for defensible space work, influencing cohesion among fire department that could be leveraged during fires. Insights from structuration theory suggest that long lasting impacts of the fire influence current and future patterns of interaction within and between local and extra-local groups, and that these changes are occurring at multiple levels.

Management implications

- Post-fire cohesion can be motivated by shared visions of forest stewardship in burned areas
- Conflict related to fire management and ignition source often become ingrained into community culture after socially impactful wildfires; extra-local organizations hoping to engage residents must take these conflicts into consideration when building new relationships and strengthening existing ones.
- While residents may become increasingly aware of local fire risk after a notable local wildfire event, this does not necessarily translate to actions that reduce that risk ahead of future fires.

Bihari, M., Hamin, E. M., & Ryan, R. L. (2012). Understanding the Role of Planners in Wildfire Preparedness and Mitigation. *International Scholarly Research Network ISRN Forestry, 2012,* **253028.**

The recent increase in wildfires that burn in residential areas has generated significant interest in the role of planning and zoning regulations as a form of risk mitigation. The authors interview 20 planners across six communities, one of which was Ruidoso, NM, to understand their role in wildfire mitigation and how they can facilitate collaborative preparedness across diverse stakeholder groups. Six themes emerged from the interview data that can broadly be summarized as barriers to fire-focused planning and varied success with different strategies, programs, and funding sources. In Ruidoso, participants raised concerns that many building codes did not align with mountain landscapes, negating their effectiveness. Ruidoso planners also saw education as a consistent responsibility of their position, particularly for visitors who they perceived as having less knowledge about fire and therefore posing a greater risk. Study participants also felt insurance companies had substantial influence over homeowner engagement in property-level preparedness; in Ruidoso, compliance certificates were issued to homeowners upon completion of certain fuels management work, which they could then take to their insurers to negotiate coverage. The authors suggested that this approach could be beneficial in other locations beyond Ruidoso. Ruidoso's focus appeared to be on property level mitigation, whereas some other study locations focused more on comprehensive planning and subdivision development with fire in mind. Findings suggest that public safety remains a powerful argument for reconsidering land use and development in WUI areas, and that planners must collaborate with emergency management professionals to ensure planning efforts remain current and prioritize safety.

Management implications

- Planners are critical players in wildfire adaptation at the local level and should be included in collaborative efforts to reduce risk wherever possible.
- Insurance companies have the capacity to act as a catalyst for motivating homeowners to engage in property-level fire mitigation activities.
- Agency officials should engage in efforts to build linkages between hazard mitigation and long-range planning efforts; doing so will likely increase participation across stakeholder groups.
- Education and outreach related to wildfire mitigation strategies and broader forest management activities like prescribed fire is still needed in the Southwest.

Owen, G., McLeod, J. D., Kolden, C. A., Ferguson, D. B., & Brown, T. J. (2012). Wildfire management and forecasting fire potential: the roles of climate information and social networks in the southwest United States. *Weather, Climate, and Society, 4*(2), 90-102.

In this paper the authors assess how fire managers in the Southwest region of the United States perceive and incorporate different types of weather forecasting and fire management information into their position responsibilities. Authors completed 37 semi-structured telephone interviews with leaders involved in federal, tribal, and state fire management in Arizona and New Mexico, as well as an online survey completed by 40 people, before completing a social network analysis. These efforts explored preferences for forecast information in the prefire and peak fire seasons and uses and perceptions of fire potential outlooks, before establishing a Southwestern social network of fire management professionals through which information is created and circulated. Pre-fire season, professionals felt information regarding fire potential, climate, and fuels/fire danger information were most useful; during peak season, this shifted to fuels/fire danger information followed by fire weather information. Over half (52%) of respondents identified regional Predictive Services meteorologists among their most trustworthy information sources. As a result, meteorologists have become central "nodes" in information dissemination within the Southwestern fire community. Person-to-person communication during the planning phase ahead of fire season was identified as critical to supporting fire manager decision making.

Management implications

- Meteorologists are trusted and well-connected sources of information in the Southwest, making it critical for them to participate in discussions around fire planning and management.
- Person-to-person interactions are highly valued avenues for information exchange that support coordination and cooperation for fire management; creating space for these interactions to occur outside of meetings or more formal communication channels can strengthen information dissemination before and during fire season.

McCaffrey, S. M., Velez, A. L. K., & Briefel, J. A. (2013). Differences in information needs for wildfire evacuees and non-evacuees. *International Journal of Mass Emergencies & Disasters*, *31*(1), 4-24.

This article examines whether evacuees from two wildfires – one of which was the 2010 Schultz Fire near Flagstaff, AZ – employed different information seeking behavior than non-evacuees. A survey was mailed to a sample of households with five miles of the burn scar perimeter, including addresses within the evacuation zone. The authors found that evacuees sought information more frequently and actively than non-evacuees during the fire. Evacuees also sought multiple sources of information more readily, with a preference for interactive information sources such as public meetings, call centers, and conversations; some of this appeared to be related to feeling that their concerns were being acknowledged. Non-evacuees reported far higher instances of radio as an information source and found it to be more trustworthy than evacuees. There were more significant differences in information seeking behaviors between these two groups *prior* to the fire; evacuees were less likely to report using newspapers, social media, and visitor centers, but far more likely to have engaged in conversations with local government representatives, fire departments, and public meetings. Evacuees also felt that it was more important for information to come from a trusted source than non-evacuees. Lastly, evacuees placed greater value on information related to fire management decisions and tended to be significantly less satisfied with overall communication prior to the fire. Compared to responses from the other survey site, the Fourmile Canyon Fire in CO, Schultz evacuees were more likely to use radio, the call center, USFS public meetings, and conversations with local government representatives during the fire and

reported lower use of television, blogs, Facebook, press conferences, scanners, and websites other than Inciweb.

Management implications

- Evacuees are more likely to be more critical of evacuation and road closure.
- Messaging consistently across multiple information outlets is critical given that evacuees appear to triangulate information they gather across different sources
- Engagement in information seeking prior to a fire affects how residents seek out information during a fire
- Non-evacuees are more likely to rely on unidirectional, somewhat passive sources of information during a fire, which may mean that communicating sudden changes in evacuation notices may take longer to reach these individuals.

Toman, E., Shindler, B., McCaffrey, S., & Bennett, J. (2014). Public acceptance of wildland fire and fuel management: Panel responses in seven locations. *Environmental Management*, *54*, 557-570.

Resident beliefs and attitudes regarding fire management and fuels treatments were examined across locales in seven states (Arizona, Colorado, Oregon, Utah, Michigan, Minnesota, and Wisconsin), one of which was Yavapai County, AZ. The authors used a longitudinal mail survey implemented in two phases: a random sample of addresses adjacent to federal land (followed by a second survey mailed to the same residents six years later. Support for prescribed fire and mechanical thinning remained high through both survey phases, although the latter was slightly more likely to be supported than the former. Arizona respondents exhibited the highest level of support for prescribed fire in the second survey phase. Respondents across all sites retained moderate confidence in managers' ability to use both prescribed fire and mechanical thinning in fuels treatments programs; once again, Arizona respondents responded most positively. Respondents agreed that mechanical thinning was less likely to impact scenic beauty or cause overharvesting compared to prescribed fire. Arizona respondents were less likely than some other locations to have had interactions with their local forest management agency, but those interactions appeared to be more positively perceived of than many other places. Two variables were significantly associated with treatment acceptance: confidence in agency managers to effectively implement the particular treatment, and beliefs in positive treatment outcomes.

Management implications
- Support for fuels treatments is connected to understanding of positive treatment outcomes; outreach and communication about fuels reduction projects should emphasize positive outcomes across both short and longer timeframes.
- Arizona residents may be more supportive of both mechanical thinning and prescribed fire than residents of other states.
- Arizona residents were less likely to have interacted with local forest management agencies; citizen-agency relationships may be less established in Yavapai County than in other parts of the US.

Eisenman, D., McCaffrey, S., Donatello, I., & Marshal, G. (2015). An ecosystems and vulnerable populations perspective on solastalgia and psychological distress after a wildfire. EcoHealth, 12, 602-610.

This article sought to examine factors influencing psychological distress, including solastalgia (defined by the authors as "loss of solace from the landscape") one year after the 2011 Wallow Fire. A survey was administered to 1109 households in five communities near the fire, which included questions from the Kessler Psychological Distress Scale. A total of 416 responses were received for a response rate of 37.5%. Approximately 35% of respondents were identified as having moderate or higher risk for depression or anxiety; this group were more likely to be women, permanent residents, respondents who actively defended their home, in the lowest income tier of the survey, and/or experiencing severe financial consequences as a result of the fire. They found that residents who were experiencing solastalgia were more likely to report symptoms of depression, anxiety, and post-traumatic stress disorder (PTSD) than those who did not. Higher household incomes and family functioning scores were common among respondents with lower levels of psychological distress. No significant differences emerged in distress experienced by full and part time residents. Together, findings suggest that solastalgia is an important consideration in discussions of community recovery after disaster that necessitates engagement from responders from a vast range of health and environmental backgrounds.

Management implications
- Cooperation between both mental health professionals and land managers after wildfires can more comprehensively address psychological needs of those affected.
- Environmental consequences of wildfire affect socio-demographic groups differently; connecting with groups identified in this article as more impacted can help target mental health resource availability.

McCaffrey, S., Rhodes, A., & Stidham, M. (2015). Wildfire evacuation and its alternatives: perspectives from four United States' communities. *International Journal of Wildland Fire, 24*(2), 170-178.

While evacuation is typically advised during wildfires, some populations may intentionally or unintentionally seek out alternatives such as sheltering in place or defending values at risk. The authors conducted 32 semi-structured interviews across four study sites, one of which was the City of Santa Fe, NM, to explore interest in evacuation alternatives. The City fire department explored the possibility of sheltering in place as an evacuation alternative following the 2000 Cerro Grande Fire, but limited support from other entities mean that no action had been taken beyond the development of a brochure with guidance on safe sheltering in place practices. Santa Fe interviewees still felt that evacuation was the safest option given the unpredictable nature of wildfire and challenges that evacuation alternatives would create for fire professionals during an event. However, there were limitations to evacuation; Santa Fe participants commented on poor ingress and egress due to twisty, narrow roads in many at-risk neighborhoods. Discussion of alternatives to evacuation piqued interest among Santa Fe participants because it provided an avenue for providing safety information related to property mitigation. One participant noted that some individuals were likely to stay regardless of official evacuation notices, and provision of information and resources in this context allowed those populations to make the most informed decision. Leveraging interest in stay and defend and shelter in place alternatives to accomplish mitigation work was a common theme across locations. Striking a balance between informing residents of their options and unintentionally encouraging residents to remain when it was unsafe to do so emerged as a challenge; however, many felt that residents were well equipped to understand the nuances of evacuation alternatives, and that detailing the challenges of staying or sheltering might

encourage greater engagement in evacuation. Mass evacuation was favored when discussion focused on first responder safety, but when emphasis was placed on increasing resident safety, providing adequate information and support to enable residents to safely stay was preferred.

Management implications

- Discussion of alternatives to evacuation with residents may provide a fruitful avenue for encouraging property-level mitigation activities.
- Encouraging discussion and information seeking related to the nuances of both wildfire events and evacuation or its alternatives will help residents make more informed decisions about what to do during a fire.
- Framing evacuation decisions as affecting resident safety versus first responder safety can influence interest in staying versus leaving.

Nowell, B., & Steelman, T. (2015). Communication under fire: The role of embeddedness in the emergence and efficacy of disaster response communication networks. *Journal of Public Administration Research and Theory*, *25*(3), 929-952.

Establishing strong working relationships is critical to effective interagency response before, during, and after wildfires. This article explores how relational (the degree of familiarity between responders prior to a fire) and institutional (shared functional role similarity and stakeholder group similarity) embeddedness influence the emergence and efficacy of interactions among responding agencies. The authors conducted a network analysis exploring response during wildfires, built using data collected via semi-structured interviews that had several components, including close-ended survey, social network roster questionnaires, and open-ended interview questions to understand each incident. Interviewees were responders to one of three large wildfire events that occurred in 2010: the Tecolote Fire, NM (n = 31), the Schultz Fire, AZ (n = 35), and the Bull Fire, CA (n = 30). Both relational and institutional embeddedness significantly shaped disaster communication network during each incident, but relational embeddedness appeared more influential. Participants working in similar organizations or entities were more likely to have pre-existing relationships; the same was true of those who had similar roles across organizations. Communication between participants who were more similar and more familiar with each other was the least problematic during fire response. Participants were most likely to share that there was a greater need for improvement in their interactions with responders who had the same affiliation but low familiarity.

Management implications
- Investing time in building relationships within and across agencies and entities at different levels prior to a fire can improve response capacity and increase familiarity with communication networks during and after wildfires

Steelman, T. A., McCaffrey, S. M., Velez, A. L. K., & Briefel, J. A. (2015). What information do people use, trust, and find useful during a disaster? Evidence from five large wildfires. *Natural Hazards, 76*, 615-634.

Existing research suggests that a disconnect between professionals and the public can emerge regarding what information is important to communicate during wildfires. The authors administered mail surveys to residents affected by five fires between 2009-2010, including the Tecolote Fire, NM, and the Schultz Fire, AZ, to understand which information sources the public sought and valued. During the events, respondents most commonly accessed information from family/friends/neighbors, newspapers,

television, radio, and maps; over 60% indicated they used all five in concert. Social media platforms like Twitter and Facebook were the least used, which may be due to their novelty at the time of this study. Interactive sources were favored during the fire. The most useful sources – the local fire department, maps, conversations with local Forest Service representatives, family/friends/neighbors, and conversations with the Incident Management Team representative – were not necessarily the most accessed, and tended to be more interactive. When asked about the most trustworthy sources, responses were similar but focused on "official" agencies and governments; the only difference was that law enforcement replaced family/friends/neighbors. Information seeking during wildfires differed from information seeking prior to a fire event, with most receiving information via newspapers, family/friends/neighbors, television, radio, and the local fire department; however, those who sought out these information sources prior to a fire were also more likely to seek them out during the fire.

Management implications

- Residents often seek out the same sources during the fire that they were using before the fire.
- Information delivered via "official" government sources are more likely to be perceived as trustworthy.
- Heavy reliance on friends, family, and neighbors for information during fire events may not necessarily increase misinformation; most recognize the limitations of information gathered from these sources.

Diaz, J. M., Steelman, T., & Nowell, B. (2016). Local ecological knowledge and fire management: What does the public understand?. *Journal of Forestry, 114*(1), 58-65.

Public understanding and support for fire management strategies in a local context has become increasingly important for encouraging fire adaptation. The authors conducted a mail survey of residents in communities adjacent to three 2010 wildfires about their knowledge of local ecology and fire management efforts. This included households near the Schultz Fire that burned near Flagstaff, AZ (n = 311 for a response rate of 21%), and the Tecolote Fire near Las Vegas, NM (n = 113 for a response rate of 10%). Findings revealed high levels of satisfaction with and support for fire management decision making on respective fires. Perceived ecological needs were a significant influence on whether respondents felt fire management approaches were appropriate. Ecological knowledge accuracy was weakly associated with education level of the respondent. The more accurate the respondent's local ecological knowledge, the higher the likelihood of them identifying the correct fire management strategy for their local fire was.

Management implications
- Residents' levels of local ecological knowledge can influence their acceptance of fire management strategies.
- Level of education can predict a resident's local ecological knowledge, but not their understanding or support of different fire management strategies.

Colavito, M. M. (2017). Utilising scientific information to support resilient forest and fire management. *International Journal of Wildland Fire*, *26*(5), 375-383.

This study sought to understand how scientific information is developed, applied, and communicated by professionals engaged in forest and fire management in the U.S. Southwest. Semi-structured interviews were conducted with 21 participants recruited at a 2014 workshop hosted by the Southwest Fire Science

Consortium that focused on resilience in Southwestern ecosystems. Findings highlighted a scalar mismatch between research endeavors and management concerns that limited managers' ability to apply scientific information. Communication of scientific information also raised challenges; some studies are difficult to interpret or access, and don't necessarily speak to the needs of a management audience in enough detail to be translatable on the ground. Some participants identified a dearth of science about drier forests and woodlands in the Southwest. Specific research needs related to social science emerged, including:

- Connections between social and ecological systems
- Effects of succession on human communities
- Developing understanding and support for management actions
- Communication and networking strategies
- Definition(s) of social resilience
- Utilizing traditional ecological knowledge, local knowledge
- Perceptions of smoke and prescribed fire

In sum, there is clear benefit to unified development of scientific approaches to fire and forestry research in the Southwest, which must incorporate flexibility and intentional communication among other key considerations in order to support actionable progress towards resilient landscapes.

Management implications

- Scientists working in the Southwest must invest time in consultation with local managers and a deeper understanding of study areas in order to improve the accessibility and applicability of resultant research.
- Interactive approaches to science dissemination such as field trips and discussions are perceived as the most effective science communication techniques among managers and scientists in AZ and NM; no single communication approach is suitable for all audiences.
- New science around fire and forests in the Southwest should prioritize *actionable* recommendations and applications of key findings.

Miller, R., Nielsen, E., & Huang, C. H. (2017). Ecosystem service valuation through wildfire risk mitigation: Design, governance, and outcomes of the Flagstaff Watershed Protection Project (FWPP). *Forests, 8*(5), 142.

This article examines the role of wildfire risk mitigation in ecosystem service valuation, focusing on the Flagstaff Watershed Protection Project (FWPP) in Arizona. Data gathered from a document review and nine key informant interviews were used to explore FWPP as a new governance structure to support payment for watershed services (PWS). The authors review the structure and purpose of FWPP. Interviewees identified key challenges to the partnership, including difficult establishing a successful mechanism for transferring money to accomplish key decisions. Successes within FWPP included process-oriented outcomes such as increased efficiency, accountability, public outreach, and inclusivity in stakeholder partnerships, as well as general outcomes such as wildfire risk mitigation. Interviewees described FWPP as an exemplary treatment project that had garnered national attention and interest in the mechanics of its implementation.

Management implications

- Increasing public outreach and education efforts via working relationships between stakeholders and NGOs provide experience and credibility for agencies and can help facilitate public support for maintenance and future forest treatment projects.

- Exploring creative solutions for wildfire mitigation may help agencies embedded in local communities overcome contentious contexts such as government failure, institutional gridlock, and budgetary shortfalls that may have limited community trust in the past.

Mottek Lucas, A., Kim, Y. S., Greco, B., Becker, D. R., Hjerpe, E. E., & Abrams, J. (2017). Social and economic contributions of the White Mountain Stewardship Project: final 10-year assessment— lessons learned and implications for future forest management initiatives. *Journal of Forestry*, 115(6), 548-558.

Arizona's White Mountain Stewardship Project (WMSP) was a USDA-funded stewardship project that ran from 2004 to 2014 and was the largest stewardship effort nationwide at the time of its inception. The WMSP focused on reducing fire risk in the wildland-urban interface and taking steps to generate a more established and stable forest product utilization industry. The authors conducted 21 interviews with agency professionals, forest products company owners, and other stakeholder groups to identify key lessons learned for future large-scale stewardship projects. Many participants attributed the success of the WMSP to a local legacy of prior collaboration and partnerships spanning several smaller projects and initiatives, which allowed the acceleration of progress and increased capacity in some instances. Those efforts had also established the local public as a supportive partner. The relationship between acres and volume of small diameter material was not well understood at the outset of the WMSP, which made forecasting projected volume and executing contracts difficult. Lack of contractor competition created challenges to completing proposed work, and motivated evaluation of how contractors were compensated for their work. WMSP treatments interacted with the historic Wallow Fire, reducing fire severity and protecting critical ecosystem services, demonstrating the success of work to date when it occurred in 2011. Partnerships such as involvement of interest groups and NGOs were key to streamlining the WMSP; however, turnover, absence of consistent funding, and mixed staff experiences tested the strength of these relationships. Study participants described a shift from traditional timber extraction to wildfire risk reduction under the WMSP.

Management implications

- Landscape-scale projects may benefit from the establishment of a contractor performance metric early on that can be used to frequently evaluate performance.
- Forest products industries tied to hazardous fuels reduction can become more stable through the sequencing and overlapping of 10-year contracts, incentivization of solutions-oriented investigation of small diameter wood harvesting and processing, and minimizing supply interruptions by estimating wood supply by location, type, size, and harvest timing relative to industry needs and market demands
- Collaborative relationships should be engaged from the outset to define the issues and scope of a project, reach agreements, select an appropriately scaled mechanism, and find resources to increase capacity
- Multi-party monitoring across ecological, social, and economic effects can improve outcomes and support the adaptive management process
- The development of transition plans can minimize disruption caused by agency turn-over

Urgenson, L. S., Ryan, C. M., Halpern, C. B., Bakker, J. D., Belote, R. T., Franklin, J. F., Haugo, R.D., Nelson, C.R. & Waltz, A. E. (2017). Visions of restoration in fire-adapted forest landscapes: lessons from the Collaborative Forest Landscape Restoration Program. *Environmental Management, 59,* 338-353.

Collaborative approaches to address wildfire (among other natural resource management challenges) is increasingly encouraged through policy and funding mechanisms introduced and supported by federal land management agencies. The authors analyze data from semi-structured interviews with 86 participants engaged in collaboration surrounding six CFLRP landscapes, including the Four Forests Restoration Initiative (4FRI) in Arizona and the Southwest Jemez Mountains in New Mexico, to understand challenges and opportunities for the CFLRP moving forward. They identified ten core challenges across study landscapes and related strategies to address them. 4FRI participants drew attention to the difficulty they experienced transitioning from agreement on ideal outcomes to specific recommendations, while both 4FRI and Jemez participants identified an absence of clarity regarding the role of stakeholder groups in US Forest Service decision-making processes for CFLRP landscapes. Threat of litigation and participation fatigue were also prominent concerns for 4FRI participants. Southwest Jemez participants drew attention to underdeveloped ideas of desired socio-economic conditions. Strategies to address many of these concerns centered on greater inclusion of stakeholder values and greater investment in collaboration from the Forest Service.

Management implications
- Scientific knowledge is critical for navigating successful CFLR projects, but social learning must occur to identify and characterize desired conditions in order for agreement about landscape-scale restoration to occur.
- Tensions between ecological science and social values in collaborative groups can be resolved through the integration of boundary organizations as mediators.

Mockrin, M. H., Fishler, H. K., & Stewart, S. I. (2018). Does wildfire open a policy window? Local government and community adaptation after fire in the United States. *Environmental Management*, *62*, 210-228.

"Windows of opportunity" have been documented after many disasters, characterized by the alignment of values among stakeholders and more streamlined policy creation and adoption to improve hazard adaptation. The authors examine the potential role of these windows on adaptation after eight wildfires, interviewing a total of 80 government employees, fire professionals, and community leaders about their approaches. Two study fires occurred in Arizona: the 2011 Wallow and Monument Fires. Wallow Fire participants described far higher levels of property-level regulation prior to the fire compared to other study sites and saw greater levels of planning and preparation for future fires after 2011 – bolstered, in part, by a long history of collaboration through initiatives such as the White Mountain Stewardship Project. Study sites where destructive fire events had not occurred in recent memory, such as Monument, saw far greater shifts in wildfire risk perceptions among interviewees. Both fire affected areas saw an uptick in Firewise community certification and an expansion of education and outreach efforts. A combination of external funding, government and staff capacity, and the presence of issue champions were necessary in most cases to motivate change after wildfire. Adaptation at the community and local governmental scales is not guaranteed after every wildfire event but does offer opportunities to focus on advancing solution-oriented actions to continue the process of fire adaptation.

Management implications
- Wildfire does serve as a window of opportunity for accelerating adaptation in Arizona; however, that acceleration may be slower or more limited if prior fires already motivated change.
- Arizona is generally perceived as a state where regulation related to fire adaption is harder due to local cultures of resistance towards government oversight; however, level of opposition can vary across local contexts and is influenced by recent fire history.

Urgenson, L.S., Nelson, C.R., Haugo, R.D., Halpern, C.B., Bakker, J.D., Ryan, C.M., Waltz, A.E., Belote, R.T. & Alvarado, E. (2018). Social perspectives on the use of reference conditions in restoration of fire-adapted forest landscapes. *Restoration Ecology*, *26*(5), 987-996.

Social aspects of forest restoration and the role they play in influencing land management remains understudied in the Southwest. The authors draw on interview data from 86 stakeholders engaged in CFLR projects across the US, including the Four Forest Restoration Initiative, AZ and the Southern Jemez Mountains, NM. Participants most commonly drew upon "pre-settlement" conditions to explore restoration decision-making, although most collaboratives settled on a combination of historic, contemporary, and future scenarios to establish reference conditions. Three core benefits to the use of reference conditions were identified, including the provision of a science-based framework for bringing stakeholders together around a common vision, improved social understanding and acceptance regarding the need for restoration, and the creation of a factual context for navigating value-laden discussions. Limitations included potential for social conflict when reference conditions are perceived to contradict other stakeholder values and interests, different interpretations of reference condition science, and limited transferability of historical reference conditions to current and future ecosystems. 4FRI participants noted that conflict often emerged between historic reference conditions and aesthetic preferences of stakeholders - particularly public land users. This study highlights the importance of collaborative discussions and establishment of reference conditions as a unifying process for landscape-scale projects that address fire. Furthermore, it calls for novel methodologies and exploratory approaches to explore social aspects of future forest conditions.

Management implications
- Shared discussions about the strengths and weaknesses of different reference conditions and their application is critical to minimalize conflict among diverse stakeholders on projects with large geographic footprints.
- Historical reference conditions are most frequently adopted and explored by collaborative groups tasked with restoration of fire-adapted forests.

Williams, E. A., & Ishak, A. W. (2018). Discourses of an organizational tragedy: Emotion, sensemaking, and learning after the Yarnell Hill Fire. *Western Journal of Communication*, *82*(3), 296-314.

The Yarnell Hill Fire near Prescott, AZ, claimed the lives of 19 hotshot firefighters in 2013. This study seeks to understand how "highly reliable organizations" like the US Forest Service respond to tragedy. The authors conducted semi-structured interviews with 24 members of various USFS hotshot crews in the year following the Yarnell Hill Fire. Some participants described a reduced capacity to conduct mentally and physically strenuous work in the days and weeks following the fire, which led many to take time off to avoid unnecessary risk taking. Familiarity with the after action review process among participants meant that they had a tendency to engage in sensemaking and learning discourses around the fire – namely, trying to understand how it happened and what insights could their own crew take

from this event. There was an expectation among participants that the Yarnell Hill Fire should provoke change in firefighting processes and decision-making from the individual and crew level all the way up to the organizational structure of wildland fire fighting at the national level. Agreement emerged among interviewees that blame-placing was not productive after such incidents.

Management implications
- Impactful fires in the southwest have widespread ramifications for how fire professionals conduct themselves and their work nationwide.
- Documentation and communication of lessons learned and associated decision-making implications is needed and expected among fire professionals after wildfires that result in firefighter fatalities.

Zanocco, C., Boudet, H., Nilson, R., Satein, H., Whitley, H., & Flora, J. (2018). Place, proximity, and perceived harm: extreme weather events and views about climate change. *Climatic Change*, *149*, 349-365.

This study examines the experiences of residents in counties affected by four extreme weather events, including the 2013 Yarnell Hill Fire in Yavapai County, AZ. A mail survey was conducted for each location, which resulted in a 16.1% response rate for Yavapai County and a 14% overall response rate. Less than 50% of respondents in Yavapai County felt that global warming had caused the Yarnell Hill Fire to be more severe, while more than 75% of respondents were less concerned or their views were unchanged regarding global warning following their experience with the fire. Yavapai County respondents also reported low levels of personal harm from the event, although community harm was much higher. Arizona survey data was markedly different from a second wildfire included in this dataset – the 2015 Valley Fire in Lake County, CA– which reported much higher connectivity between event severity and global warming, indicating that political contexts may influence response.

Management implications
- Political ideology influences concern about global warming and its connection to wildfire
- The Yarnell Hill Fire was perceived as causing community harm in Yavapai County.

Bradshaw, K. (2019). Agency engagement with stakeholder collaborations, in wildfire policy and beyond. *Arizona State Law Journal*, *51*, 437.

The author was hired by the Administrative Conference of the United States to develop a longitudinal analysis of federal agency interactions with stakeholder collaborations around wildfire in Alaska, Arizona, and Maine to address the narrative that federal officials manage Western lands without incorporating local interests and values. This effort included a small number of interviews with collaborators engaged in 4FRI in Arizona, which revealed concerns about lack of inclusion and confusion about the role of the stakeholder group in federal decision making. Consensus was honored when it emerged through the 4FRI stakeholder group, and absence of the traditional NEPA process allowed greater agreement to emerge around actions and next steps. The author describes 4FRI as well-represented and advocated for in political arenas, noting that despite its unique design, 4FRI was considered a "poster child" for USFS stakeholder collaboration. Despite the perceived successes of 4FRI's social processes, some politicians raised concern about the pace of work executed by this group.

Management implications
- Agency officials in northern Arizona believe they make better decisions because of diverse input that emerges from collaboration with stakeholders

- More intentional and thorough collaborative processes can lead to greater social acceptance for forest and fire management outcomes.
- Collaboration allows stakeholders who do not have the permission, capacity, or access to public lands management and Congressional decisions feel that their shared objectives are heard and included in ways that would not otherwise be possible in the Southwest.

Azpeleta Tarancón, A. A., Kim, Y. S., Padilla, T., Fulé, P. Z., & Sánchez Meador, A. J. (2020). Coconstruction of ecosystem services management in tribal lands: Elicit expert opinion approach. *Weather, Climate, and Society,* 12(3), 487-499.

The Mescalero Apache Tribal Lands (MATL) of southern New Mexico provide unique ecosystem services that are threatened by climate change. The authors implemented an iterative survey with 15 scientists and practitioners familiar with the MATL to identify ecosystem services that have high utility, are irreplicable, and are under a high level due to climate change (e.g., risk of uncharacteristic wildfire), with the intent to support management prioritization. Firewood was identified as having significant utility across different ecosystems within the MATL. Wildfire and climate change were identified as the most important threats to address in order to protect MATL ecosystem services. Participants shared great interest in use of prescribed fire, but their suggestions for burn frequency varied significantly. Reintroduction of fire emerged as a consistent approach for regulating and reducing the threat of climate change impacts.

Management implications
- Incorporating and elevating human values into prioritization of ecosystem management approaches and locations is critical to protect cultural use of tribal lands.
- Diverse perspectives surrounding values and risk and threats to ecosystem services can be effectively melded to determine management decisions that can garner significant support.

2020s

Colavito, M., Satink Wolfson, B., Thode, A. E., Haffey, C., & Kimball, C. (2020). Integrating art and science to communicate the social and ecological complexities of wildfire and climate change in Arizona, USA. *Fire Ecology*, 16:19, 1-10.

This article chronicles the development and unveiling of an art exhibition held in Flagstaff and Tucson, AZ, and Albuquerque, NM, borne through collaboration between boundary organizations that enhance communication between managers and scientists. Visitors to the Flagstaff and Tucson events were invited to participate in a survey about their experience after viewing the exhibit, resulting in 115 responses (69 in Flagstaff and 46 in Tucson). A second survey was administered to organizers, artists, scientists and managers involved in the exhibit to gage their experiences too (n = 24). Descriptive statistics drawn from these data find that visitors reported an increased understanding of how climate change is affecting fire regimes in the Southwest after attending the exhibit. Visitors were also more likely to support local management actions after attending. The survey of exhibit creators revealed high support for art as a communication mechanism for wildfire, and artists reported engaging in new conversations about fire as a result of their involvement. Scientists and managers all agreed that the exhibit accurately reflected the scientific messages they had hoped to convey. There was significant support for a similar event in the future.

Management implications
- Art can effectively communicate complex ecological issues surrounding fire to diverse audiences
- Collaboration around art as a communication strategy can promote new partnerships between scientists and managers during development.
- Boundary organizations can foster innovative collaborations to support science communication around wildfire and other ecologically complex topics.

Edgeley, C. M., & Burnett, J. T. (2020). Navigating the wildfire–pandemic interface: Public perceptions of COVID-19 and the 2020 wildfire season in Arizona. *Fire*, *3*(3), 41.

The emergence of the COVID-19 pandemic raised questions about public behavior and safety during wildfires during the 2020 fire season. The authors were preparing to conduct a survey of households affected by two recent Arizona wildfires – the 2017 Goodwin Fire and 2018 Tinder Fire – and modified a question set to investigate perceptions of COVID-19 and their intersection with wildfire as the pandemic began. A total of 301 responses were received for a 21% response rate. Respondents from households that had engaged in greater levels of planning for wildfire evacuation were more likely to report that the pandemic would not affect their evacuation plans during a wildfire. Respondents from a household where someone with a pre-existing health condition lived were more likely to have somewhere to stay during an evacuation. Two groups of respondents were less likely to have reported preparing their property for wildfire that year as a result of the pandemic: households where someone with a disability lived and part-time residents. Findings suggest that preparedness for wildfire and pandemic risks are interconnected, and that the pandemic may exacerbate existing inequities related to wildfire within communities.

Management implications
- The COVID-19 pandemic may have long-lasting ramifications on community cohesion and inequities surrounding property-level mitigation in Arizona, as many were unable to undertake usual mitigation actions during 2020.
- Planning for wildfire evacuation has the potential to enhance preparedness for other risks (such as pandemics) too. Concurrent communication about interconnected hazards can support increased social adaptation.

Greiner, S. M., Grimm, K. E., & Waltz, A. E. (2020). Managing for resilience? Examining management implications of resilience in southwestern national forests. *Journal of Forestry*, *118*(4), 433-443.

Public land policy increasingly prioritizes goals related to resilience under changing climate. The authors explore how USFS staff in Region 3 (Arizona and New Mexico) are managing for resilience as it is presented in the 2012 Planning Rule (necessitated by the 1976 National Forest Management Act). Interviews were conducted with 26 USFS staff. Participants described resilience as the ability of an ecosystem to recover structure and function; however, there was variation in discussion of the role that social and engineering considerations played in use of this term. Notably, no definitions provided by participants focused on the resilience of human communities in forest ecosystems. Interviewees had varied perspectives on how to operationalize resilience in forest planning and tended to gravitate towards approaches that aligned with their specialty. The National Cohesive Wildland Fire Management Strategy was identified as one of several policy documents that promoted discussion about resilience in R3. Planning for resilience was complicated by the diversity of conditions at various scales and the need for flexibility that limited a more structured, guided approach. Fire was one of few areas where interviewees agreed that definitions and plans for resilience were clear, in large part due to widely

agreed upon ecological parameters such as fire regimes that have been characterized in depth by scientists. 4FRI was often pointed to as an example of an effort to plan and manage for resilience. Some participants identified a need for metrics to help determine whether actions resulted in resilience, and saw collaboration and partnerships as a pathway forward because that provided opportunities to leverage new resources and insights.

Management implications
- Metrics for assessing resilience should be adapted to suit local ecological contexts
- The role of wildfire in resilient southwestern landscapes is more clearly defined than other considerations as a result of clear scientific guidance on ecosystem-fire processes.
- Social considerations for landscape resilience are largely overlooked by planners in the Southwest

Mockrin, M. H., Fishler, H. K., & Stewart, S. I. (2020). After the fire: Perceptions of land use planning to reduce wildfire risk in eight communities across the United States. *International Journal of Disaster Risk Reduction*, *45*, 101444.

Land use planning has received increased attention in recent years as one potential approach to reduce wildfire risk to communities. After wildfires, there are often opportunities to introduce, modify, or expand land use planning approaches, for example introducing new building codes when destroyed homes are being rebuilt. The authors interviewed 80 individuals engaged in some element of wildfire response or land use planning across eight study areas affected by wildfire, including the communities of Wallow and Monument, AZ. Six core themes related to land use planning emerged: (1) land use planning as not necessary and/or effective, (2) limited resources and capacity to pursue planning and regulation, (3) concerns about the effects of regulation and planning on real estate and the local economy, (4) public objection to land use planning and regulations, particularly in rural areas, (5) challenges to coordinating planning efforts across scales and jurisdictions, and (6) concerns about ability to revise land use and planning efforts over time. Interviewees from the Monument area highlighted juxtapositions between socially diverse communities within the same landscape with vastly different levels of support for land use planning strategies. Wallow interviewees highlighted challenges engaging residents in voluntary programs such as Firewise as an indicator that regulatory approaches would not be well received. Insurance companies had introduced requirements regarding specific construction materials in the Wallow area in order to access coverage, and professionals did not want to duplicate those existing regulatory efforts either. The authors present a conceptual framework for understanding local wildfire-related land use policy implementation.

Management implications
- Social diversity within and between communities within the same county means that land use planning efforts and related regulations are unlikely to be consistently supported, particularly in rural areas that are seeing new development in Arizona.
- Professionals in areas recently affected by wildfire can access a wide range of rsources and assistance to determine whether introduction of or changes to land use planning will be effective in their area (e.g., the USDA-funded Community Planning Assistance for Wildfire project, FAC Net).
- Land use planning and regulation is not a one-size-fits-all solution to risk reduction after wildfire.

Steffey, E., Budruk, M., & Vogt, C. (2020). The mitigated neighborhood: Exploring homeowner associations' role in resident wildfire-mitigation actions. *Journal of Forestry*, *118*(6), 613-624.

This study uses the theory of planned behavior to explore the role of homeowners associations (HOAs) in wildfire mitigation efforts on private property in Prescott, AZ. The authors use a mixed methods approach: first, key informant interviews were conducted with eight neighborhood leaders or residents, followed by a survey mailed to 2,400 homes in the Prescott area both with and without HOA oversight (response rate 28%, n = 644). Interviews revealed that HOAs acted as champions for wildfire mitigation, but that funding was often a barrier to mitigation completion. HOAs were able to funnel funding and community service such as contractors and clean up days to their residents to increase engagement in mitigation activities. Unmanaged vacant lots were another challenge; communication with lot owners was scarce and few had an interest in investing in mitigation on that land despite the risk it posed to adjacent properties. Survey analysis showed that residents living in HOAs had significantly different responses compared to those who do not. HOAs were critical for dissemination of information and education regarding wildfire mitigation, and promote mitigation efforts as a normative behavior. Respondents living in areas without HOA governance had lower incomes and were less likely to be retired, indicating that non-HOA populations may be in greater need of financial support for mitigation. Interconnectivity of risk and the need for mitigation across property lines and communities emerged as a critical need; HOA respondents had far higher risk perceptions than non-HOA respondents. Overall, this study suggests that HOAs act as a catalyst for homeowner mitigation efforts in the Prescott area.

Management implications
- HOAs are successful at disseminating information and motivating the integration of Firewise efforts to promote wildfire mitigation
- Funding to support mitigation may be most needed in communities without HOAs where structure and regulation, in addition to higher income, are not prevalent.
- Inaction around mitigation on vacant lots is a key barrier to cross-boundary management.
- There is growing interest in management of risk across communities in the Prescott area.

Abrams, J., Greiner, M., Schultz, C., Evans, A., & Huber-Stearns, H. (2021). Can forest managers plan for resilient landscapes? Lessons from the United States national forest plan revision process. *Environmental Management*, *67*, 574-588.

This study analyzes the forest plan revision process for three national forests, including the Kaibab National Forest in northern Arizona, to understand how planners and stakeholders both perceive of and operationalize resilience in an increasingly complex institutional and political environment. The authors conducted a total of 64 semi-structured interviews with USFS planners and non-USFS stakeholders (Kaibab n = 23). Kaibab participants provided highly consistent conceptualizations of resilience that aligned with understandings of fire-frequented forests and a need to address current fuel loads among other fire-adjacent management needs. However, some felt that translating ideas about resilience to address changing climate would likely result in the emergence of disagreement depending on its implications for forest management. Tribal partnerships were also critical to Kaibab interviewees – some of whom saw connectivity between their own ideas of resilience and native American worldviews. Kaibab interviewees also noted that the forest plan revision process allowed them to incorporate greater flexibility in use of fires managed for objectives other than full suppression. The study concluded that forest plan revision processes offered abundant opportunities to incorporate resilience principles into land management.

Management implications
- Non-USFS engagement in forest planning processes may be limited by availability of funding; identifying pathways to increase non-governmental capacity to participate can ensure inclusive collaboration.
- Forest plan revisions provide opportunities to create greater operational flexibility regarding fire use and management in the Southwest.

Aslan, C. E., Souther, S., Stortz, S., Sample, M., Sandor, M., Levine, C., ... & Dickson, B. (2021). Land management objectives and activities in the face of projected fire regime change in the Sonoran desert. *Journal of Environmental Management*, *280*, **111644.**

Wildfire is increasingly occurring in the non-fire adapted Sonoran Desert ecoregion of Arizona, requiring strategic land management objectives that can address this changing fire regime. The authors held a workshop with managers working in this region and introduced maps generated by modeling efforts to identify risk of large fires over the next 20 years to understand whether current land management activities and objectives will continue in the future. Interviews were then conducted with managers of 25 jurisdictions in the Sonoran Desert, followed by a survey provided to 88 land manager contacts in the study area asking about their perceptions of their organization's adaptive capacity (response rate 35.4%, n = 32). When discussing fire, most participants gravitated towards fire suppression; less consideration was given to fire prevention activities like outreach and education or fuels management. Most managers felt that fire management was a necessary activity for recreation management. There was widespread uncertainty among participants about the future of current activities and objectives under changing fire regimes, although federal managers reported a higher likelihood of adopting new activities compared to non-federal managers. Survey findings revealed that past fires were not a widespread driver of change for management strategies and objectives. Funding availability was commonly cited as a constraint for supporting progressive management change. Overall, cross-boundary responses to fire regime change are affected by organizational variations in resources, information, and objectives.

Management implications
- Identifying which values will benefit from fire management and prevention in non-fire-adapted Southwestern ecosystems (e.g., recreation) can encourage greater engagement and proactivity among managers.
- Federal managers believe they have greater flexibility and capacity to adopt new land management activities and objectives than non-federal land managers; this may result in jurisdictional disparities regarding management innovation within the same landscape over time.

Greiner, S.M., Schultz, C.A. & Kooistra, C. (2021). Pre-season fire management planning: the use of Potential Operational Delineations to prepare for wildland fire events. *International Journal of Wildland Fire,* **30, 170–178.**

US fire scientists are developing Potential Wildfire Operational Delineations, also known as 'PODs', as a pre-fire season planning tool to promote safe and effective wildland fire response, strengthen risk management approaches in fire management and better align fire management objectives. PODs are a collaborative planning approach based on spatial analytics and expert input that seeks to identify potential wildfire control lines and assess the desirability of fire before ignition. The authors conducted 36 semi-structured interviews with individuals engaged in PODs planning efforts on US Forest Service lands, 18 of which were in the Southwest on the Tonto, Carson, and Santa Fe National Forests.

Participants broadly described benefits for communication with different audiences using PODs maps and described the PODs process as an opportunity for increased coordination and agreement-building. Southwestern interviewees also saw PODs as a structure for formally capturing and maintaining local fire management expertise. Contextual factors such leadership commitment to use of PODs, staff culture, capacity, social and political pressure, and ecological conditions were described as factors that might challenge or complicate effective use of PODs during wildfire. Participants were also asked for their thoughts on how the assignment and use of PODs might be improved; responses varied from a need for dedicated leadership to demonstrate commitment to the use of this planning tool, incorporation of other land ownerships beyond national forest into planning processes, and greater consideration regarding the timing of stakeholder inclusion, to increasing seasonal functionality within the product. The authors emphasize that their findings demonstrate the potential for PODs as a planning tool during these early stages of use, and suggest that it is one of a suite of tools and techniques for developing a comprehensive strategy for fire management. The article concludes that "PODs could be a tool for overcoming some of the persistent incentives, coordination challenges and decision heuristics that have led to an emphasis on short-term rather than long-term risks and objective."

Management implications
- Partner and stakeholder support is likely to have a significant influence on the use of PODs for any given national forest, underscoring the importance of their thoughtful inclusion in the planning process.
- PODs offers a platform for documenting local experience and knowledge about fire management, which may be particularly valuable for national forests where turnover is high or few staff are dedicated to fire management.
- Engaging in the PODs process offers an opportunity for increased coordination prior to a fire event.

Plecki, A. F., Akamani, K., Groninger, J. W., Brenner, J. C., & Gage, K. L. (2021). Homeowner perceptions and responses to buffelgrass invasion risk in the Tucson, Arizona Wildland-Urban Interface. *Heliyon*, *7*(5), e07040.

This study analyzes homeowners' level of awareness and perceived risk about invasive buffelgrass, a plant that thrives with increasing fire frequency and intensity. An online survey was conducted through 38 homeowners associations in the Tucson area wildland urban interface, resulting in 117 responses. Respondents indicated a high level of awareness regarding buffelgrass, but ecological knowledge was far more limited. Approximately half of respondents felt that buffelgrass invasion had placed their home at risk. Higher levels of engagement in HOAs were associated with higher involvement in buffelgrass management and removal. Concern about buffelgrass was also related to concern about fire risk, motivating greater mitigation efforts at the property level. Longer term residents were less likely to engage in buffelgrass management than newer residents. Findings suggest that resident engagement in fire mitigation and invasives management are related and can be leveraged to advance community adaptation, although there is likely to be heterogeneity within communities that should be accounted for.

Management implications
- Leveraging concern about other threats such as invasive species can promote greater resident engagement in fire adaptation in non-fire adapted ecosystems at risk.
- HOAs can play a critical role in encouraging vegetation management efforts that reduce wildfire risk in the Tucson area.

Roos, C. I., Swetnam, T. W., Ferguson, T. J., Liebmann, M. J., Loehman, R. A., Welch, J. R., ... & Kiahtipes, C. A. (2021). Native American fire management at an ancient wildland–urban interface in the Southwest United States. *Proceedings of the National Academy of Sciences*, *118*(4), e2018733118.

The authors combine ethnography, archaeology, paleoecology, and ecological modeling to infer intensive wood and fire use by Native American ancestors of Jemez Pueblo, NM, and their consequences for fire in the local landscape. Within this effort, interviews were conducted with tribal elders to trace fire and fuelwood uses at different spatial scales. They learned that human impacts at local scales were driven by fuelwood collecting. Interviewed tribal research participants shared their great respect and caution for fire (in addition to recognition of ecological benefits when used appropriately), which the authors suggest means that fire use would have been subject to social sanction. Melding these interviews with the various other data collection efforts shared in this article allowed for a comprehensive history of Native American fire use at Jemez Pueblo to emerge across four landscape "zones": the home, village, fields, and forests and woodlands.

Management implications
- Integration of various ecological and ethnographic methods can reveal rich relationships between Native Americans and fire in the Southwest.
- The ancient Jemez WUI offers an alternative model for fire management in modern WUI in the western United States, whereby local management of woody fuels through uses such as domestic wood collecting coupled with small prescribed fires can support more self-reliant and resilient communities.

Russell, G., Champ, J. G., Flores, D., Martinez, M., Hatch, A. M., Morgan, E., & Clarke, P. (2021). Doing work on the land of our ancestors: Reserved treaty rights lands collaborations in the American Southwest. *Fire*, *4*(1), 7.

Increasing the capacity of tribes and federal land management agencies to restore fire-adapted landscapes has emerged as a common need in the Southwest. This article examples the Reserved Treaty Rights Land (RTRL) program, focusing on its implementation to support collaborative fuel management projects across national forests in Arizona and New Mexico. The lead author conducted semi-structured interviews with tribal land managers and USFS personnel who work with tribes. The 2020 Medio Fire near Santa Fe, NM, emerged as a case study of RTRL success; a portion of the fire was contained using the Pacheco Canyon Prescribed Burn – an area recently treated thanks to funding from the RTRL program. The 500-acre prescribed burn was conducted under a partnership between the Pueblo of Tesuque and the USFS. USFS interviewees emphasized the importance of allowing tribes to conduct cultural surveys on federal lands prior to project implementation and advocated for this practice to continue on projects funded through other means too. Despite the success of the Pacheco Canyon RTRL project, allocations for the RTRL program are underrepresented in the DoI's budget; some interviewees thought this may be connected to concerns about BIA-funded staff working on non-tribal lands and lack of credit given to the BIA for USFS partnership work. Other limitations emerged during interviews, including a lack of support for building staff capacity for tribal partners in RTRL projects, a requirement for all RTRL work to occur on non-tribal land, and lack of outreach or engagement from USFS in potential RTRL projects in other areas of the Southwest. The authors conclude that modification of the RTRL program to make tribal lands eligible for funding would allow the BIA to receive project accomplishments and allow greater investment from the BIA in RTRL projects.

Management implications
- Use of RTRL funds can produce socially and ecologically impactful fuel treatments that effectively support fire suppression tactics.
- The current structure of RTRL funding limits BIA benefits and capacity to engage creating inequities in the fire adaptation process across boundaries; non-tribal USFS partners who engage in RTRL projects should accommodate these challenges and seek to rectify them wherever possible.

Davis, E. J., Huber-Stearns, H., Caggiano, M., McAvoy, D., Cheng, A. S., Deak, A., & Evans, A. (2022). Managed wildfire: A strategy facilitated by civil society partnerships and interagency cooperation. *Society & Natural Resources*, *35*(8), 914-932.

Managing wildfires for objectives other than full suppression ("managed fire") is one of several tools federal land managers can take advantage of when conditions are suitable; however, policy and science surrounding this strategy are currently limited. The authors conduct two interview cases studies in northern New Mexico and southwestern Utah to examine barriers and opportunities among 40 managers and stakeholders seeking use managed wildfire from 2018 to 2021. Over this time period, New Mexico interviewees described shifts from innovative local solutions to state-federal differences in managed fire to more institutionalized support that alleviated some planning barriers. New Mexico participants also described how non-agency partners were able to advocate for increased use of managed fire to generate support across organizational scales, often resulting in the formation of collaboratives and coalitions. These groups were then able to seek funding for mitigation projects in priority areas, draw the attention of varied audiences to the need for managed fire, and work together to implement prescribed fire with the goal of preparing for future managed fires in shared landscapes. Concern about use of terminology around managed fire, particularly in public facing contexts, emerged among New Mexico interviewees based on experiences with prior fires. In both case study locations, the COVID-19 pandemic, drought, and agency direction presented setbacks for fuels reduction and restoration goals. The New Mexico case study indicates that engagement of numerous stakeholders and collaboratives or coalitions can advance scientific need, public awareness, and conducive policy conditions for managed fire. Additional social science research about managed fire can continue to provide evidence and structure for managers tasked with meeting multiple objectives during wildfires. Such efforts should propose clear pathways to application and invite the creation of space for discussion between managers and scientists in order to produce actionable outcomes.

Management implications
- Use of, and increases in, managed fire can be advanced through the cultivation of collaboratives or coalitions that can advocate for this approach across multiple levels and arenas.
- Diverse social and ecological barriers to managed fire exist in the Southwest, including the COVID-19 pandemic, drought, inconsistent or poorly defined terminology, and shifting development patterns; however, the exact nature and influence of these barriers varies between local actors and contexts.
- Meaningful discourse and engagement between scientists and managers moving forward should seek to support actionable outcomes and pathways to increased use of managed fire.

Edgeley, C. M., & Colavito, M. M. (2022). Characterizing Divergent Experiences with the Same Wildfire: Insights from a Survey of Households in Evacuation, Postfire Flood Risk, and Unaffected Areas After the 2019 Museum Fire. *Journal of Forestry*, *120*(6), 660-675.

The Museum Fire burned near Flagstaff, AZ, during the summer of 2019. The authors administered a mixed-mode survey to residents across the Flagstaff area representing three groups: (1) all households in the evacuation area, (2) all households in a newly established flood risk area created by the Museum Fire's burn scar, and (3) a random sample of residents in unaffected areas of the City of Flagstaff who acted as a control group for data analysis. A total of 787 responses were received, with a response rate of 22.4% for the mail portion of the survey. All surveyed groups expressed high concern for future wildfires and post-fire flood events, although respondents who identified as female had higher risk perceptions compared to male respondents. The majority of respondents (71.9%) participated in public meetings about the Museum Fire virtually rather than attending in person. Formal sources of information such as law enforcement, USFS, and Coconino County were perceived as most trustworthy by respondents. Despite this, Inciweb, the online clearinghouse for sharing official fire updates, was one of the lesser-accessed information sources. Experiences with the Museum Fire, which was ignited by equipment being used to reduce hazardous fuel loads on national forest land, did not negatively affect support for future forest management. Prescribed fire was the most supported forest management approach, but few supported increased smoke that came with that. A majority agreed that they would vote in support of taxpayer funded forest restoration projects and agreed that intergovernmental collaborations were the best way to accomplish risk reduction goals in the Flagstaff area. The study highlights small variations in perceptions of risk and communication depending on experiences with the Museum Fire but indicates that the event had little effect on public support for continued forest management.

Management implications
- More targeted communication about wildfire and post-fire flood risks during and after fire events is needed to avoid confusion and ensure that residents are receiving relevant information that they can act upon.
- Providing access to public meetings about wildfire and post-fire flooding across various modes can increase engagement; members of the public are increasingly attending online through livestream functions made available on social media and government pages.
- Residents seek out information during and after wildfires from multiple sources; therefore, agencies and organizations should coordinate to share consistent messages across platforms.
- Support for prescribed fire may conflict with opposition to reduced air quality; addressing this conflict requires more intentional communication about the full process of forest management strategies.

Grimm, K. E., Thode, A. E., Satink Wolfson, B., & Brown, L. E. (2022). Scientist Engagement with Boundary Organizations and Knowledge Coproduction: A Case Study of the Southwest Fire Science Consortium. *Fire*, *5*(2), 43.

Coproduction of knowledge is increasingly examined in wildfire contexts. This study examines the role of one boundary organization – the Southwest Fire Science Consortium (SWFSC) – in the generation and dissemination of knowledge among scientists. The authors explore insights from 28 semi-structured interviews with scientists engaged with the SWFSC. Interviewees who reported greater engagement with the SWFSC also engaged in a greater array of knowledge coproduction activities such as workshops and field trips. The most common co-production activity among interviewees was "understanding

needs, values, and time frame of the user"; far fewer interviewees described situating this activity within considerations of broader social context. Scientists with greater engagement in coproduction were also more likely to describe multidirectional knowledge exchange. Barriers such as larger time commitments and absence or need for trust building emerged as common challenges to engaging in co-production. Most interviewees identified the SWFSC as a platform that increased their engagement in knowledge coproduction efforts in the Southwest, pointing specifically to the value that interacting with managers and practitioners had for advancing research collaborations. Findings indicate that boundary organizations, such as SWFSC, can foster knowledge coproduction, but that they may need to further explore ways to address challenges for knowledge coproduction activities that involve greater time commitment or institutional challenges.

Management implications
- Frequent evaluation of knowledge coproduction efforts across the duration of a project or partnership can provide greater insights than one-off assessments at the conclusion of a coproduced effort.
- Boundary organizations like JFSP consortia can support both trust building and co-production at local, state and regional levels.
- Knowledge co-production is a valuable process for overcoming complex management and research challenges.

Huber-Stearns, H. R., Davis, E. J., Cheng, A. S., & Deak, A. (2022). Collective action for managing wildfire risk across boundaries in forest and range landscapes: lessons from case studies in the western United States. *International Journal of Wildland Fire*, *31*(10), 936-948.

Insights to advance motivation and coordination of collective action across boundaries at varied scales is increasingly critical for effective wildfire management and risk mitigation. To better understand collective action as a cross-boundary function in different contexts, the authors conducted semi-structured interviews with 102 local actors across five different landscape-level case study sites and projects, one of which was the Rio Grande Water Fund in northern New Mexico (n = 20). Six boundary spanning functions emerged across case studies: (1) convening meetings and agreements; (2) implementing projects; (3) community outreach; (4) funding support; (5) project planning; (6) scientific expertise. These efforts were nested within boundary spanning settings, concepts, and objects that emerged at each location. Boundary organizations emerged as essential to cross-boundary wildfire risk management given their ability to foster and sustain partnerships and collaborative processes. Prescribed burning was a consistent unifying activity across contexts as it necessitated the formation of partnerships, multi-party communication, and cross-boundary planning in most instances. Findings suggest that interagency collaboration and boundary spanning is a slow process that can be accelerated with the support of diverse individuals and organizations that can transcend gaps in agency capacity, increase engagement and improve connectivity.

Management implications
- Prescribed fire can facilitate the establishment of cross-boundary partnerships that can spur conducive conditions for collective action around other land management activities.
- Understanding the purpose and limitations of boundary objects at the outset of a cross-boundary, collective action-oriented effort, can streamline work and identify more resource-efficient pathways.
- Non-agency entities can increase cross-boundary capacity and improve engagement in collective action at the landscape level for fire management and risk mitigation.

Nowell, B., Steelman, T., Velez, A. L., & Albrecht, K. (2022). Co-management during crisis: insights from jurisdictionally complex wildfires. *International Journal of Wildland Fire*, *31*(5), 529-544.

"Co-management" is an increasingly common goal in multi-jurisdictional responses to wildfire, although there is disagreement about what this term implies. The authors explore the concept of co-management during nine jurisdictionally complex wildfire events during 2017, using document analysis and interviews with 74 agency administrators and land managers. Study fires spanned five states including Arizona. Interviewees typically offered one or more of three interlinked descriptions of co-management as it applied to jurisdictionally complex fires: (1) global orientation toward co-management, which entailed balancing the facilitation of unity while respecting diversity, (2) strategic orientation toward co-management, which emerged in several forms: cooperative assistance to achieve varied goals across participating organizations, negotiated coordination that requires these varied goals to be merged into one, or collaborative singularity, which unifies all jurisdictions under one mission, and (3) the relationship of co-management to structures of network governance, where co-management emerged as a function of the governance networks interviewees were embedded within. These characterizations represent a continuum from collectivistic orientations to co-management that emphasize creating unity to individualistic orientations that emphasize respecting diversity. Findings suggest that co-management is distinctly different from collaboration in complex jurisdictional settings. Co-management was found to be complex in large part because it was seen as an individual-level phenomenon that must play out in a perceived network of interdependencies between actors. The paper concludes with the introduction of a multi-level theoretical framework for co-management during jurisdictionally complex wildfires.

Management implications
- Co-management is complex and can be approached from multiple angles during jurisdictionally complex wildfires.
- Challenges to co-management during crisis are affected by perceived tensions between forging unified actions and respecting diversity. This can be compounded by perceptions of "fairness" regarding how power should be shared during jurisdictionally complex fires.
- Fire management and ICS positions should be aware of differences in characterizations and perceptions of co-management and leverage constant and clear shared communication to navigate differing conceptualizations.

Burnett, J.B., and Edgeley, C.M. (2023). Factors influencing flood risk mitigation after wildfire: Insights for individual and collective action after the 2010 Schultz Fire. *International Journal of Disaster Risk Reduction,* **93, 103791.**

Flooding caused or exacerbated by wildfire burn scars are increasingly common in the Southwest, where monsoonal precipitation can generate significant risk to communities and other local values. The 2010 Schultz Fire near Flagstaff, AZ, is one such example of a recent fire that resulted in post-fire flooding. The authors conducted a mixed mode survey to understand resident experiences with post-fire floods in the years following Schultz, including current risk perceptions and capacity for engaging in collective action to address flooding across property lines and jurisdictional boundaries. A total of 407 completed questionnaires were received for a 22.6% response rate. Concerns about the longevity of flood risk associated with the Schultz burn scar were far more common than concerns about the current level of risk to respondents' properties. Respondents most willingly engaged in temporary mitigations such as sandbag use; structural modifications and other mitigation activities that required significant financial or time investments were scarcely reported. Those who willingly engaged in mitigation actions on their

own property were far more likely to engage in collective actions that sought to address flood risk at larger spatial scales, such as attending public meetings and working with neighbors to address possible water flow between their property lines. Engagement in these actions were informed by their risk perceptions and experience with flooding in the years after the fire. This study revealed connectivity between individual and collective risk reduction actions, and highlights several individual factors that influence uptake of these efforts across scales.

Management implications
- Resident willingness to engage in mitigation at one scale typically leads to interest in engaging in mitigation at other scales.
- Funding and accessibility to mitigation resources are commonly the greatest barrier to flood risk reduction after fire on private property; provision of flood mitigation cost sharing or grants, tailoring information to the individual property level and bringing materials such as sandbags to affected neighborhoods rather than requiring them to travel elsewhere to collect them can significantly improve uptake of mitigation efforts.

Fillmore, S. D., & Paveglio, T. B. (2023). Use of the Wildland Fire Decision Support System (WFDSS) for full suppression and managed fires within the Southwestern Region of the US Forest Service. *International Journal of Wildland Fire*, **32(4), 622-635.**

The Wildland Fire Decision Support System (WFDSS) is a formal decision support system intended to aid federal agency employees in decision-making about extended fire incidents. This study sought to better understand how wildfire managers use WFDSS and how it informs their decision making, focusing on the experiences of US Forest Service employees in USFS Region 3 (Arizona and New Mexico). Semi-structured interviews were conducted with 46 USFS employees. Interviewees perceived of WFDSS as an efficient platform for sharing information and logging the chronology of decisions made over the course of a fire event. While there appeared to be no agreed upon approach to using WFDSS among R3 employees, some indicated that successful use of WFDSS to generate decisions should produce consensus about the next steps for management of a specific incident. Participants saw value in annual WFDSS refresher courses but were concerned about the absence of specialized trainings that could accommodate the establishment of higher-level WFDSS users who could guide teams using the program and provide rapid assistance. WFDSS appeared to be most valuable in decision-making when fires were expected to burn for extended periods of time – particularly during fires managed for objectives other than full suppression. Tailoring WFDSS trainings to better reflect user engagement, such as refreshers for specific positions rather than generalized trainings, can retain and increase effective use of WFDSS during fire events.

Management implications
- Managers in the Southwest largely use WFDSS for information and documentation rather than decision making as it is intended.
- WDFSS is a valuable tool for decision-making around managed fires used for objectives other than full suppression in the Southwest as there is less pressure to rapidly respond, allowing more intentional program use.
- Creating opportunities for high-competency WFDSS training can ensure more intentional use of the program; mentor-based training may be an effective way to fill this need.

Hjerpe, E., Colavito, M.M., Edgeley, C.M., Burnett, J.T., Sanchez Meador., A., Combrink, T., and Vosick, D. (2023). Measuring the Long-Term Costs of Uncharacteristic Wildfire: A Case Study of the 2010 Schultz Fire in Northern Arizona. *International Journal of Wildland Fire*, **online early.**

The long-term financial costs of wildfire are challenging to accurately represent, given the multi-faceted impacts they can cause to social, ecological, and infrastructural values. Methodologies to address this effort are often underdeveloped or incomplete. The authors present a preliminary effort to calculate longitudinal costs of the 2010 Schultz Fire, AZ, over a ten-year period, using economic analyses and survey data among other approaches to understand government, resident and ecosystem costs. Analysis of data from multiple sources produced an estimate of $108 to $113 million in costs during and after the Schultz Fire. Survey data from 407 households (response rate 22.6%) showed that most households that had purchased flood insurance most commonly ceased renewing coverage between 2012-2015. The cost of flood insurance had almost doubled over the ten-year study period, as compared with an earlier survey of affected households in 2011. Insurance claims often resulted in payouts of just over half the estimated cost of damage, and uninsured damages cost respondents an average of $12,111. Out-of-pocket mitigation activities and related upkeep cost the average household $7,227 over the ten years following the Schultz Fire. The study also documented long-term impacts to well-being caused by the fire, indicating that improved documentation of individual health-related expenses may cause the total costs of wildfire to increase. Housing values also decreased in the area near the Schultz Fire for several years following. This research highlights a need for the establishment of additional efforts to measure longitudinal fire impacts in order to advance and improve methodologies.

Management implications
- Households begin to consider not renewing flood insurance at the two-year mark after fires, indicating that this is an opportune time to reengage outreach efforts and communication about the duration and ongoing risk of post-fire flooding.
- The majority of households who make claims related to post-fire flood damage are under-insured.
- Long term impacts to mental health can emerge as a result of post-fire flooding. Wherever possible, resources to support affected residents should be made available for several years after impacts cease.

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