

Social science research related to wildfire management: an overview of recent findings and future research needs

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Abstract. As with other aspects of natural-resource management, the approach to managing wildland fires has evolved over time as scientific understanding has advanced and the broader context surrounding management decisions has changed. Prior to 2000 the primary focus of most fire research was on the physical and ecological aspects of fire; social science research was limited to a small number of studies. However, as more people moved into fire-prone areas interest grew in understanding relevant social dynamics. This growing interest was supported by increased funding for fire research overall with the creation of the Joint Fire Science Program in 1998 and the National Fire Plan in 2000. In subsequent years, a significant body of research has developed on the human dimensions of wildland fire covering diverse topics including: attitudes towards pre-fire mitigation, social acceptability of fire and fuels management, community preparedness, public response during fires, citizen–agency communications and post-fire recovery. This paper reports on two aspects of a Joint Fire Science Program project intended to take stock of the key social science lessons provided to date: a basic review of findings in the non-economic fire social science literature and identification of future research needs.

Additional keywords: citizen–agency interactions, communication and outreach, community preparedness, fuels management, homeowner mitigation, public acceptance, risk perception, trust.

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Introduction

Since their earliest days, the management of wildland fires has been a central part of the missions of USA federal land-management agencies. As with other aspects of natural resource management, the approach to managing wildland fires has evolved over time as scientific understanding has advanced and the broader context surrounding management decisions has changed. The primary focus of most fire research has been on the physical and ecological aspects of fire. Prior to 2000, non-economic social science research on wildland fire management was limited to a small number of studies (e.g. Stankey 1976; Cortner *et al.* 1984; Gardner *et al.* 1985; Carpenter *et al.* 1986; Taylor and Mutch 1986; Manfredo *et al.* 1990). However, as more people moved into fire-prone areas, most commonly referred to as the wildland–urban interface (WUI), interest grew in understanding relevant social science dynamics. This interest was supported by increased funding for fire research overall with the creation of the Joint Fire Science Program in 1998 and the National Fire Plan in 2000. In the subsequent years, a significant body of research has developed on the human dimensions of wildland fire. Much of this work, particularly in the early years of research, focussed on the diverse issues

contributing to attitudes towards fire-mitigation efforts before a fire. Over time, social science research has continued to examine specific factors that contribute to social acceptability of fire and fuels management while expanding to cover a greater diversity of topics including public response during fires (e.g. evacuation and communication) and post-fire recovery.

This paper reports on two aspects of a Joint Fire Science Program project to take stock of the key lessons provided by the social science research on fire: a general overview of findings in the fire social science literature and identification of future research needs.

Approach

The research team conducted an extensive review of the available social science literature on wildland fires. Criteria for inclusion in the review included the following:

- (1) Use of an established social science methodology to address one or more fire-management issues. Economic studies were excluded from the review owing to fundamental differences in approaches and resulting data;

- (2) Publication in peer-reviewed or editor-reviewed literature (including USDA Forest Service General Technical Reports and Conference Proceedings); and
- (3) Publication or in press status^A between January 2000 and July 2008. Using these criteria, literature searches were then conducted using several online databases (e.g. Web of Science, Treesearch, Google Scholar) using pre-identified keywords (e.g. wildfire, social, public, perception, mitigation, community, thinning, prescribed burn, evacuation, communication).

Searches were also performed on the most prominent social scientists active in studying fire-management issues. The resulting database of articles was provided to an external group of scientists who reviewed it for completeness. Additional articles suggested for inclusion were reviewed for consistency with the above criteria. Through these efforts, the research team completed a review of more than 200 publications of research results by well over 100 authors.

Only 7% of study locations in articles that met our search criteria were outside the United States. Although several Australian studies had been conducted before our cut-off date, they were not published in journal or editor peer-reviewed form. In recent years, particularly since 2010, several peer-reviewed articles have been published on fire social science outside the United States, primarily from Australia and Canada. The following summary therefore is most applicable for the United States; however, while dispersed across a range of countries and research topics, the findings from international articles published within our search timeframe, as well as after, suggest that many of the basic social wildfire dynamics are similar across countries. Of the remainder of the study sites, 8% were national-level USA studies, 56% of sites were in the western USA, 13% were in the Midwest, 12% were in the southern USA and 4% were in the north-eastern USA. Although the higher proportion of sites in the western USA could suggest that results are less applicable to other areas of the country, we did not see a strong indication that key social dynamics vary substantially across regions. In fact, social science studies that included multiple study sites often found that there were more similarities than dissimilarities between sites. When differences were found they were generally attributed to specific local contextual elements such as history, building style or ecological conditions. This is not to discount such differences when they do occur, as they can influence many of the key dynamics identified throughout this article.

Using an approach similar to grounded theory (a systematic method that applies a set of rigorous procedures to identify conceptual categories and their interrelationships, see Glaser and Strauss 1967), the research team read each article and categorised key findings. Findings from individual articles were then organised into overarching themes across articles. Preliminary results from this analysis were provided to an external group of scientists for review and discussion in a workshop held in Portland, Oregon, in August 2008. The workshop was attended by 18 of the primary social scientists working on fire-management issues (including the authors). Over 2 days

workshop attendees reviewed findings, considered their relevance to managers, and discussed future research needs. Based on feedback from the workshop, the research team refined the themes presented below. In addition, the team compiled a list of research needs identified during the discussion, which was reviewed by workshop participants as well as a small group of managers. Results and the details of the research-needs process will be discussed later in the article.

Findings and discussion

Below we provide a general overview of social science research findings related to wildfire, followed by a brief discussion of identified research needs. Findings are organised into 12 (often overlapping) themes, which fall into four general areas: pre-fire mitigation and preparedness, community–agency dynamics, experiencing a fire and institutional considerations. For each theme we indicate the number of articles addressing the topic and an overview of key patterns identified across studies. What follows is not comprehensive. Space limitations mean we cannot cite every article associated with a theme or finding. Nor can we cover every aspect of a research area or go into detail about specific variation across studies. Instead we hope to provide a sense of the range and depth of the social science research that has been undertaken related to wildfire, as well as the range of researchers who are involved. The patterns identified under each theme required multiple studies to be described in this document, indicating that it is likely a consistent dynamic. More detailed results are being developed using an article database updated through December 2010.

Pre-fire mitigation and preparedness

Public acceptance of fire and fuels management (64 articles)

Substantial research has been conducted on the social acceptability of fuels-management treatments (primarily thinning and prescribed fire) and the agencies that implement these treatments. At a general level, research finds high levels of public support for thinning and prescribed-fire activities on public lands with a high fire risk. Two variables in particular were consistently associated with higher acceptance across sites: familiarity with a treatment technique and trust in those implementing the treatment. Other factors that have been found to influence treatment acceptance include beliefs about certain treatment outcomes (e.g. effect on wildlife, potential for escape, aesthetics), consideration of local values and context, perceptions of wildfire risk and citizen involvement in decision making. Treatment preference is also influenced by land ownership and location, with a preference for use of prescribed fire in remote areas and thinning in the WUI (Table 1). The influence of demographic characteristics (e.g. age, education, income, proximity of one's home to the forest) on fuels-management preferences are so mixed that they are largely inconclusive (Shindler and Toman 2003; Weible *et al.* 2005; Winter *et al.* 2006; Walker *et al.* 2007).

^AArticles whose status was 'in press' as of July 2008 are indicated by an asterisk (*).

Table 1. Factors that influence fuel-treatment preference and support

Factors	Citation
Familiarity with treatment techniques	Shindler and Toman 2003; McCaffrey 2004b, 2006; Weisshaupt <i>et al.</i> 2005; Absher and Vaske 2006; Blanchard and Ryan 2007; McGee 2007
Trust or confidence in those implementing a practice	Shindler and Toman 2003; Winter <i>et al.</i> 2004; McCaffrey 2006; Gunderson and Watson 2007; Vaske <i>et al.</i> 2007
Beliefs about or attitudes towards treatment outcomes	Loomis <i>et al.</i> 2001; Shindler and Toman 2003; Winter <i>et al.</i> 2006; Blanchard and Ryan 2007; McGee 2007; Vaske <i>et al.</i> 2007; McCaffrey <i>et al.</i> 2008; Vining and Merrick 2008; Shindler <i>et al.</i> 2009*
Consideration of local values or context	Winter <i>et al.</i> 2002; Brunson and Shindler 2004; Flint and Haynes 2006; Burns and Cheng 2007; Gunderson and Watson 2007; Liou <i>et al.</i> 2008
Perception of risk of wildfire	Weible <i>et al.</i> 2005; Bright and Newman 2006; Gunderson and Watson 2007
Citizen involvement in decision making	Winter <i>et al.</i> 2002; Shindler and Toman 2003; Blanchard and Ryan 2007
Location of treatment	Winter <i>et al.</i> 2002; Brunson and Shindler 2004; Weisshaupt <i>et al.</i> 2005; Bright and Newman 2006; Ryan <i>et al.</i> 2006; McCaffrey <i>et al.</i> 2008

Table 2. Factors contributing to the decision to mitigate risk

Factors	Citation
Trade-offs with other amenity values	Winter <i>et al.</i> 2002; Monroe <i>et al.</i> 2003; McCaffrey 2004a; Collins 2005; Nelson <i>et al.</i> 2005; Brenkert-Smith 2006; Sturtevant and McCaffrey 2006; Daniel 2007; Cohn <i>et al.</i> 2008
Perceived effectiveness of risk-reduction activities	Winter and Fried 2000; Kent <i>et al.</i> 2003; Absher and Vaske 2006; Brenkert-Smith <i>et al.</i> 2006; Bright and Burtz 2006; Martin <i>et al.</i> 2007; Cohn <i>et al.</i> 2008
Social context in which mitigation actions were considered	McCaffrey 2004a; Agrawal and Monroe 2006; Brenkert-Smith <i>et al.</i> 2006; Shiralipour <i>et al.</i> 2006; Blanchard and Ryan 2007
Individual capacity to implement actions	Kent <i>et al.</i> 2003; Bright and Burtz 2006; Holmes <i>et al.</i> 2007; Martin <i>et al.</i> 2007

Public perceptions of wildfire risk (30 articles)

Findings from research on perception of wildfire risk are consistent with findings in the wider field of risk perception and demonstrate the complex and subjective nature of this topic (Daniel 2007; McCaffrey 2008). Although most people living in the WUI perceive a high wildfire risk, specific assessments and response to the same risk can vary based on an array of factors such as: individual probability calculations; the timeframe and spatial area that are being considered; perceived vulnerability to potential negative outcomes; and type of negative consequences considered (Carroll *et al.* 2004; McCaffrey 2004a, 2008; Martin *et al.* 2007; Cohn *et al.* 2008; Steelman 2008). Personal considerations, such as risk tolerance and balancing trade-offs between the risk of wildfire and the benefits of exposure (i.e. living in the forest), will also affect response to the risk (Daniel 2007; McCaffrey 2008). Previous experience with fire has mixed effects: in some cases prior experience leads to greater perceptions of risk, in others it can have a dampening effect (Winter and Fried 2000; McCaffrey 2004a; Blanchard and Ryan 2007; Flint 2007; Cohn *et al.* 2008). Ultimately, perceiving the risk is a necessary, but not sufficient, condition to taking action (Daniel *et al.* 2002; Kent *et al.* 2003; McCaffrey 2004a; Steelman 2008), as the actual decision to mitigate will also depend on other factors (see 'Homeowner preparedness' below).

Homeowner preparedness and mitigation (41 articles)

Numerous studies have examined homeowner preparedness and found that a majority of residents in fire-prone areas are aware of potential risk and have taken some type of action to

protect their property (Kent *et al.* 2003; McGee and Russell 2003; Monroe and Nelson 2004; McGee 2005; Absher and Vaske 2006; Brenkert-Smith 2006; Cvetkovich and Winter 2008; McCaffrey 2008). The decision to implement specific mitigation actions is influenced by the interaction of several factors including: social context in which mitigation options were considered; trade-offs with other amenity values such as aesthetics or provision of wildlife habitat; perceived effectiveness of risk reduction activities; and individual capacity to implement actions (e.g. time, money, physical ability) (Table 2). In addition, many fire mitigation measures are undertaken for reasons other than fire (McGee 2005; Nelson *et al.* 2005; Bright and Burtz 2006). In terms of fire protection responsibility, homeowners tend to see themselves as responsible for mitigating the fire risk on their property, whereas government agencies are seen as being responsible for educating residents about hazards and managing public lands (Winter and Fried 2000; Kent *et al.* 2003; McGee and Russell 2003; Brenkert-Smith *et al.* 2006; Weisshaupt *et al.* 2007; Cohn *et al.* 2008; Vining and Merrick 2008).

Community preparedness (20 articles)

A smaller body of ongoing work has focussed on how community action shapes preparedness with a particular focus on the role of Community Wildfire Protection Plans (CWPPs), which communities are required to have in place in order to access treatment funds through the *Healthy Forests Restoration Act* (2003). At the time of the workshop several studies had been completed, but were not yet published in the peer-reviewed literature, and so did not fit our criteria. However, several

general findings could be identified and showed that CWPPs can help build and maintain strong relationships between all stakeholders (agencies, local groups and industry) for sharing resources and overcoming jurisdictional boundaries. Factors that contribute to the success of community response and CWPPs include: active agency involvement; inclusion of community groups, leaders and networks; trust among parties and a common vision or threat (Flint and Haynes 2006; Jakes *et al.* 2007; Fleeger 2008; Fleeger and Becker 2010*).

Community–agency dynamics

Community–agency interactions (30 articles)

Several studies have identified the importance of effective citizen–agency interactions to citizen acceptance of agency fuel treatments, homeowner preparedness, effective response during a fire event and post-fire recovery (Shindler and Toman 2003; Cohn *et al.* 2006; Ryan and Hamin 2006; Sturtevant and Jakes 2008; Toman *et al.* 2008b). Findings from this work provide evidence of the value of both formalised collaborative efforts to develop fire- and fuel-management plans and less-formal interactions that facilitate information exchange (McCaffrey 2004b; Fleeger 2008; McCaffrey *et al.* 2008; Ryan and Hamin 2008; Toman *et al.* 2008b). When executed effectively, such activities tend to increase citizen trust and understanding, both of which are, as stated earlier, associated with increased support for management practices (Sturtevant *et al.* 2005; Toman *et al.* 2006; Flint and Luloff 2007). Similar to research examining citizen involvement in general agency planning activities, fire research highlights the importance of engaging the public early in the planning process, a commitment of agency leadership and use of an open and transparent approach to decision-making (Sturtevant *et al.* 2005; Burchfield 2007; Fleeger 2008). In addition, findings also highlight the value of using existing groups, such as homeowner associations, where possible. This can help tailor the communication message to local needs and utilise existing relationships to reach a broader audience, as well as add credibility to the fire-management message (Ryan and Hamin 2006; Burns *et al.* 2008; Sturtevant and Jakes 2008; Toman *et al.* 2008b).

Trust (10 articles)

Studies specific to trust and fire management support those found in the larger body of work on trust in natural resource management, which has shown that trustworthy relations are a common thread that runs through effective decision-making processes. These studies and reviews demonstrate that as trust increases, support for management programs also increases (Winter *et al.* 2004; Shindler 2007; Vaske *et al.* 2007). Factors that contribute to trustworthy relations include: competence of agency personnel; perception of shared norms and values; perception of fairness and equity in the planning process; and following through on commitments (Winter *et al.* 2004; Olsen and Shindler 2007; Vaske *et al.* 2007; Cvetkovich and Winter 2008; Liljeblad *et al.* 2009*).

Communication and outreach (41 articles)

Although few studies focussed solely on communication, many included research questions related to communication

and outreach. Findings from this work supports findings from research in other fields (Bier 2001; Toman *et al.* 2006) showing that well-designed communication programs can be effective at increasing public understanding, influencing attitudes about management activities, encouraging homeowners to adopt fire-safe behaviours and improving relations with local citizens. Fire studies have shown that information content is a key component and needs to provide specific explanations of both what to do and why it needs to be done, while also taking into account local context and conditions (Jacobson *et al.* 2001; Parkinson *et al.* 2003; McCaffrey 2004b; Zaksek and Arvai 2004; Monroe *et al.* 2006; Toman *et al.* 2006; Winter *et al.* 2006). Mode of delivery is also important. Although many programs tend to gravitate towards unidirectional methods, such as mass media, the most effective methods for influencing attitudes or behaviour are interactive approaches such as one on one consultations, small workshops, town hall-type meetings, field trips and tours and demonstration areas (Blatner *et al.* 2001; Kent *et al.* 2003; McCaffrey 2004b; Ryan and Hamin 2006; Toman and Shindler 2006; Toman *et al.* 2006, 2008b).

Experiencing a fire

Community actions and reactions during and following a wildfire event (23 articles)

Research in this area has been more limited than that on actions taken before a wildfire event. Research from other hazards has shown that as people seek to make sense of events, obtaining up-to-date information can be an important way to retain some semblance of control and ease anxiety (Kumagai *et al.* 2004; McCool *et al.* 2006; Hodgson 2007). Findings from the studies specific to wildfire confirm this dynamic and indicate that during a fire, affected individuals want information about how the fire influences their lives (e.g. effects to their home and property, evacuation information) delivered with greater frequency and specificity than is often available through agency channels. If real-time information (during the fire) is not fulfilled by the agencies, people are likely to rely on alternate, less-formal information networks such as family and neighbours (Cohn *et al.* 2006; Taylor *et al.* 2007; Sutton *et al.* 2008).

Wildfire events can result in a community ‘pulling together’ as residents reach out to help each other. Alternatively, wildfires can extend, and sometimes amplify, pre-existing disagreements and serve to fragment communities (Rodriguez-Mendez *et al.* 2003; Kumagai *et al.* 2004; Carroll *et al.* 2005; Burchfield 2007; Olsen and Shindler 2007).

Post-fire recovery is influenced by the quality of citizen–agency interactions before and during the fire (e.g. timeliness and accuracy of information, transparency of communication) and community characteristics (e.g. existing relationships, economic stability) (Kumagai *et al.* 2004; Carroll *et al.* 2005; Burchfield 2007; Downing *et al.* 2008; Toman *et al.* 2008a). Projects that allow citizens to participate in post-fire recovery efforts, particularly those in locally important areas (e.g. around subdivisions or in popular recreation areas), have been found to help citizens recover and reconnect with the forest (Carroll *et al.* 2005; Hull and Goldstein 2006; Ryan and Hamin 2006; Burns *et al.* 2008; Toman *et al.* 2008a).

Recreation (14 articles)

Research specific to the effects of fire and fire management on recreation is limited. Visitation to areas that have experienced a fire (either prescribed or wild) generally decreases immediately after a fire (particularly severe fire), but gradually increases as the forest recovers (Englin *et al.* 2001; Loomis *et al.* 2001; Hesselin *et al.* 2003; Brown *et al.* 2008). Some forest users prefer restrictions on recreation activities after a fire whereas others do not. Specific response can vary by type of user (e.g. tourists *v.* local residents), type of activity (e.g. camping *v.* mountain biking) and level of effect of the fire on the area (e.g. road closures, smoke) (Englin *et al.* 2001; Loomis *et al.* 2001; Thapa *et al.* 2004; Brown *et al.* 2008).

Institutional considerations

Policy (31 articles)

Papers with a specific focus on wildfire policy have primarily focussed on the evolution of national policy and their contributions to creating or reducing the wildfire risk (Davis 2001; Busenberg 2004; O'Laughlin 2005; Dale 2006; Jensen 2006; Steelman and Burke 2007). From a community standpoint, recent policies to shift wildfire management from a reactive focus on suppression to a more proactive and comprehensive approach have had mixed success; whereas some communities have benefited greatly, others have not (Steelman *et al.* 2004; Moseley 2007). Research suggests however that rather than focusing efforts on redesigning policies, the current policies could be more effective if fully implemented (i.e. all aspects are fully funded) (Steelman *et al.* 2004; Jensen 2006).

Planning (29 articles)

Research related to planning was often a by-product of research in other areas (e.g. planning recommendations from studies on the ecological aspects of fire management). Research has highlighted the importance of how the WUI is defined (Stewart *et al.* 2007) and of working at the appropriate scale and taking local considerations into account (Hann and Bunnell 2001; Gunderson 2006; Knotek and Watson 2006; McCool *et al.* 2006; Olsen and Shindler 2007). Including local citizens and groups in the planning process has also been shown to facilitate relationships and acceptance (Ostergren *et al.* 2006; Ryan and Hamin 2006).

Organisational effectiveness (12 articles)

Research in this area has been very limited, but suggests that risk perceptions and attitudes of agency personnel can significantly limit the willingness of managers to actively engage in the full range of pre-fire mitigation activities, from working with communities to selecting more risky practices (e.g. wildland fire use). Lack of internal support (whether money, staffing or leadership) can also be a significant limiting factor (Miller and Landres 2004; Aplet 2006; Arvai *et al.* 2006; Dale 2006; Doane *et al.* 2006; Davenport *et al.* 2007; González-Cabán 2007; Williamson 2007).

Future research needs

Beyond discussion of what conclusions could be drawn from existing research, a focus of the Portland workshop was identifying key research gaps. Subsequent to the workshop the Joint Fire Science staff asked us to refine the research-gap discussion into a list that could help inform future funding

decisions. After reviewing discussion notes, a list of 36 research needs was drawn up. As this list did not neatly fall under the original twelve themes (for instance some themes had no identified research needs) the needs were organised into six new topic areas: fire management and public response, fire preparedness and mitigation, temporal connections, coordination of planning efforts, organisational effectiveness and community capacity and sustainability. The resulting list of research needs was sent to all scientists who attended the workshop, three additional scientists external to the workshop and a small group of 11 managers. Managers who completed this review worked for federal, state and local government agencies, and one non-governmental organisation, and included representatives from western, mid-western, southern and eastern states. Each reviewer was asked to assess validity and completeness of the list and to identify the six research needs they deemed most important.

Comments from both scientists and managers indicated that the identified needs were comprehensive and well reasoned. All items received some level of support; however, five received such limited support that they are not considered in the final discussion below. Although most needs received approximately equal levels of support from managers and scientists, a few were supported more by managers than scientists (indicated with a superscript letter M), whereas others were supported more by scientists than managers (indicated with a superscript letter S). The following presents a brief summary of research needs for each of the six topic areas. Within each topic area, specific research needs are presented according to general order of priority, with needs receiving more support reported first.

Fire management and public response

The research focus to date on understanding public response before fires means that there is a need for more work on public response to and understanding of the entire fire-management cycle. This is particularly important as the emphasis shifts away from full suppression to encompass broader goals. New research therefore needs to assess factors that influence agency fire-management decisions during and after a fire and interactions with local residents and groups. This topic had the most identified research needs (eleven). Of these, the top five were:

- Identifying smoke communication best practices;
- Understanding the dynamics of evacuation and alternative models to evacuation^M;
- Developing more-detailed knowledge of the multiple components of trust specific to fire management;
- Assessing public views of different fire-suppression strategies and tactics including wildland fire use;
- Evaluating the role of volunteer fire departments in the wildfire-management system.

Fire preparedness and mitigation

Research needs in this area focus on building upon the existing body of research in relation to mitigation and preparedness on both public and private property. These include:

- Developing a synthesis of the existing work to help clarify factors influencing preparedness activities;

- Examining the effect of variations in risk perception (public v. agency and across cultural groups)^M;
- Comparing differences in approaches and effectiveness of CWPPs across locations;
- Understanding the influence of different policies on preparedness activities; and
- Identifying factors that influence maintenance of mitigation activities over time.

Temporal connections

Research to date has tended to focus on problems and decisions that reflect a single point in time. However, managers could benefit from insights about how current actions and choices may influence future events and citizen beliefs, attitudes and behaviours. Longitudinal research will provide a better understanding of the temporal connectivity of a range of fire issues from prevention and fuel-reduction activities to decisions and experiences during an event, to post-fire decision making and recovery. Specific topic areas identified were:

- Identifying differences in communication needs at each temporal stage;
- Determining the long-term viability of local groups formed around a fire threat;
- Evaluating the long-term effectiveness of different incentive programs to encourage fire mitigation^M; and
- Identifying long-term effects and implications of outside Incident Management Teams on communities.

Coordination of planning efforts

With the rapid expansion of the WUI into fire-prone ecosystems, coordinating planning efforts at all levels of government has the potential to improve fire risk-reduction efforts. However, little research has looked at how planning activities actually affect wildfire risk. Specific topics to address this gap were:

- Understanding how local, state, county and multiscale land-use planning increases or decreases wildfire exposure;
- Identifying factors that contribute to the willingness to pass ordinances requiring mitigation measures and the effectiveness of such measures; and
- Identifying factors that hinder agency managers from working with communities.

Organisational effectiveness

Existing findings suggest that internal barriers can significantly limit an agency's ability, willingness, or both, to engage in the full range of fire-mitigation and restoration activities. Further research could help agencies develop internal policies and practices that will best support effective fire management. Specific topics identified were:

- Building a 'map' of the fire-management system (i.e. pre-fire, during an event, post-fire) in order to understand the interactions of the different players and help identify potential synergistic effects of any structural change;

- Understanding the consequences when federal land-management agencies focus an increasing number of functions around wildfire, particularly during unusually active fire years^M;
- Assessing the implications of shifting more fire costs to local governments; and
- Understanding the effect or effectiveness of stewardship, or both, contracting authority^M.

Community capacity and sustainability

Finally, research has highlighted the importance of local capacity in successful implementation and maintenance of wildfire-mitigation activities. A better understanding is needed of how different community characteristics (e.g. human capital, social networks, physical infrastructure) can affect community capacity to adapt to fire. Although receiving less overall support than other topic areas, specific topics that received support were:

- Developing concrete methods to identify the various forms of capacity in fire-prone areas that agency personnel could use to adapt wildfire programs to their local communities^S;
- Understanding the ability of different communities to prepare for wildfire;
- Examining the ability of intermediary organisations and social networks to help build community capacity for wildfire mitigation; and
- Assessing the role and contributions of local, state and federal agencies in building and maintaining community capacity.

Conclusion

Since 2000, a substantial body of work has been undertaken on social issues of fire management. The work has shown that at a general level there is substantial public support for mitigation efforts before fires, whether they are treatments on public land (i.e. mechanised thinning, prescribed fire) or actions taken by homeowners on their property. Results from this work have provided important information that can help managers identify the most effective ways to begin to address the diverse social issues of fire management. However, there is also a clear need for additional research, to address existing gaps in our understanding and to address new and emerging fire-management challenges. Although fire itself is a biophysical process, fire management is essentially a social one. Having an accurate understanding of key dynamics whether before, during or after a fire event will be integral to ensuring that future fire management can most efficiently ensure safety and minimise negative effects on communities, while at the same time fostering both ecologically beneficial and cost-effective use and management of fire.

References

- Absher JD, Vaske JJ (2006) An analysis of homeowner and agency wildland fire mitigation strategies. In 'Proceedings of the 2005 northeastern recreation research symposium', 10–12 April 2005, Bolton Landing, NY. (Eds JG Peden, RM Schuster) USDA Forest Service, Northeastern Research Station, General Technical Report NE-GTR-341, pp. 231–236. (Newtown Square, PA)

- Agrawal S, Monroe MC (2006) Using and improving social capital to increase community preparedness for wildfire. In 'The public and wildland fire management: social science findings for managers'. (Ed. SM McCaffrey) USDA Forest Service, Northern Research Station, General Technical Report NRS-GRT-1, pp. 163–167. (Newtown Square, PA)
- Aplet GH (2006) Evolution of wilderness fire policy. *International Journal of Wilderness* **12**, 9–13.
- Arvai J, Gregory R, Ohlson D, Blackwell B, Gray R (2006) Letdowns, wake-up calls, and constructed preferences: people's responses to fuel and wildfire risks. *Journal of Forestry* **104**, 173–181.
- Bier VM (2001) On the state of the art: risk communication to the public. *Reliability Engineering & System Safety* **71**, 139–150. doi:10.1016/S0951-8320(00)00090-9
- Blanchard B, Ryan RL (2007) Managing the wildland–urban interface in the northeast: perceptions of fire risk and hazard reduction strategies. *Northern Journal of Applied Forestry* **24**, 203–208.
- Blatner KA, Carroll MS, Daniels SE, Walker GB (2001) Evaluating the application of collaborative learning to the Wenatchee fire recovery planning effort. *Environmental Impact Assessment Review* **21**, 241–270. doi:10.1016/S0195-9255(00)00080-9
- Brenkert-Smith H (2006) The place of fire. *Natural Hazards Review* **7**, 105–113. doi:10.1061/(ASCE)1527-6988(2006)7:3(105)
- Brenkert-Smith H, Champ PA, Flores N (2006) Insights into wildfire mitigation decisions among wildland–urban interface residents. *Society & Natural Resources* **19**, 759–768. doi:10.1080/08941920600801207
- Bright AD, Burtz RT (2006) Firewise activities of full-time versus seasonal residents in the wildland–urban interface. *Journal of Forestry* **104**, 307–315.
- Bright AD, Newman P (2006) How forest context influences the acceptability of prescribed burning and mechanical thinning. In 'The public and wildland fire management: social science findings for managers'. (Ed. SM McCaffrey) USDA Forest Service, Northern Research Station, General Technical Report NRS-GTR-1, pp. 47–52. (Newtown Square, PA)
- Brown RNK, Rosenberger RS, Kline JD, Hall TE, Needham MD (2008) Visitor preferences for managing wilderness recreation after wildfire. *Journal of Forestry* **106**, 9–16.
- Brunson MW, Shindler BA (2004) Geographic variation in social acceptability of wildland fuels management in the western United States. *Society & Natural Resources* **17**, 661–678. doi:10.1080/08941920490480688
- Burchfield J (2007) Community impacts of large wildfire events: Consequences of actions after the fire. In 'People, fire, and forests: a synthesis of wildfire social science'. (Eds TC Daniel, MS Carroll, C Moseley, C Raish) pp. 124–140. (Oregon State University Press: Corvallis, OR)
- Burns M, Cheng AS (2007) Framing the need for active management for wildfire mitigation and forest restoration. *Society & Natural Resources* **20**, 245–259. doi:10.1080/08941920601117348
- Burns MR, Taylor JG, Hogan JT (2008) Integrative healing: the importance of community collaboration in postfire recovery and prefire planning. In 'Wildfire risk: human perceptions and management implications'. (Eds WE Martin, C Raish, B Kent) pp. 81–97. (Resources for the Future: Washington, DC)
- Busenberg G (2004) Adaptive policy design for the management of wildfire hazards. *The American Behavioral Scientist* **48**, 314–326. doi:10.1177/0002764204268988
- Carpenter EH, Taylor JG, Cortner HJ, Gardner PD, Zwolinski MJ, Daniel TC (1986) Targeting audiences and content for forest fire information programs. *The Journal of Environmental Education* **17**, 33–41. doi:10.1080/00958964.1986.9941416
- Carroll MS, Cohn PJ, Blatner KA (2004) Private and tribal forest landowners and fire risk: a two-county case study in Washington state. *Canadian Journal of Forest Research* **34**, 2148–2158. doi:10.1139/X04-085
- Carroll MS, Cohn PJ, Seesholtz DN, Higgins LL (2005) Fire as a galvanizing and fragmenting influence on communities: the case of the Rodeo-Chediski fire. *Society & Natural Resources* **18**, 301–320. doi:10.1080/08941920590915224
- Cohn PJ, Carroll MS, Kumagai Y (2006) Evacuation behavior during wildfires: results of three case studies. *Western Journal of Applied Forestry* **21**, 39–48.
- Cohn PJ, Williams DR, Carroll MS (2008) Wildland–urban interface residents' views on risk and attribution. In 'Wildfire risk: human perceptions and management implications'. (Eds WE Martin, C Raish, B Kent) pp. 23–43. (Resources for the Future: Washington, DC)
- Collins TW (2005) Households, forests, and fire hazard vulnerability in the American West: a case study of a California community. *Environmental Hazards* **6**, 23–37. doi:10.1016/J.HAZARDS.2004.12.003
- Cortner HJ, Zwolinski MJ, Carpenter EH, Taylor JG (1984) Public support for fire-management policies. *Journal of Forestry* **82**, 359–361.
- Cvetkovich GT, Winter PL (2008) The experience of community residents in a fire-prone ecosystem: a case study on the San Bernardino National Forest. USDA Forest Service, Pacific Southwest Research Station, Research Paper PSW-RP-257. (Albany, CA)
- Dale L (2006) Wildfire policy and fire use on public lands in the United States. *Society & Natural Resources* **19**, 275–284. doi:10.1080/08941920500460898
- Daniel TC (2007) Perceptions of wildfire risk. In 'People, fire, and forests: a synthesis of wildfire social science'. (Eds TC Daniel, MS Carroll, C Moseley, C Raish) pp. 55–69. (Oregon State University Press: Corvallis, OR)
- Daniel TC, Weidemann E, Hines D (2002) Assessing public tradeoffs between fire hazard and scenic beauty in the wildland–urban interface. In 'Homeowners, communities, and wildfire: science findings from the National Fire Plan, Proceedings of the 9th international symposium on society and resource management', 2–5 June 2002, Bloomington, IN. (Ed. PJ Jakes) USDA Forest Service, North Central Research Station, General Technical Report NC-GTR-231, pp. 36–44. (St Paul, MN)
- Davenport MA, Anderson DH, Leahy JE, Jakes P (2007) Reflections from USDA Forest Service employees on institutional constraints to engaging and serving their local communities. *Journal of Forestry* **105**, 43–48.
- Davis C (2001) The West in flames: the intergovernmental politics of wildfire suppression and prevention. *Publicus* **31**, 97–110. doi:10.1093/OXFORDJOURNALS.PUBJOF.A004911
- Doane D, O'Laughlin J, Morgan P, Miller C (2006) Barriers to wildland fire use. *International Journal of Wilderness* **12**, 36–38.
- Downing JL, Hodgson RW, Taylor JG, Gillette SC (2008) Fire information for communities at risk in interface wildfires: lessons learned from the 2003 Southern California megafires. In 'Fire social science research from the Pacific Southwest Research Station: studies supported by National Fire Plan funds'. (Eds DJ Chavez, JD Absher, PL Winter) USDA Forest Service, Pacific Southwest Research Station, General Technical Report PSW-GTR-209, pp. 135–152. (Albany, CA)
- Englin J, Loomis J, González-Cabán A (2001) The dynamic path of recreational values following a forest fire: a comparative analysis of states in the Intermountain West. *Canadian Journal of Forest Research* **31**, 1837–1844. doi:10.1139/X01-118
- Fleeger WE (2008) Collaborating for success: community wildfire protection planning in the Arizona White Mountains. *Journal of Forestry* **106**, 78–82.
- Fleeger WE, Becker ML (2010) Decision processes for multi-jurisdictional planning and management: community wildfire protection planning in Oregon processes. *Society & Natural Resources* **23**, 351–365. doi:10.1080/08941920802120067

- Flint CG (2007) Changing forest disturbance regimes and risk perceptions in Homer, Alaska. *Risk Analysis* **27**, 1597–1608. doi:10.1111/J.1539-6924.2007.00991.X
- Flint CG, Haynes R (2006) Managing forest disturbances and community responses: lessons from the Kenai Peninsula, Alaska. *Journal of Forestry* **104**, 269–275.
- Flint CG, Luloff AE (2007) Community activeness in response to forest disturbance in Alaska. *Society & Natural Resources* **20**, 431–450. doi:10.1080/08941920701211850
- Gardner PD, Cortner HJ, Widaman KF, Stenberg KJ (1985) Forest-user attitudes toward alternative fire management policies. *Environmental Management* **9**, 303–311. doi:10.1007/BF01867302
- Glaser BG, Strauss AL (1967) 'The discovery of grounded theory: strategies for qualitative research.' (Aldine Publishing: Chicago)
- González-Cabán A (2007) Human factors in fire management. In 'Fire social science research – selected highlights'. (Eds A González-Cabán, RW Haynes, S McCaffrey, E Mercer, A Watson) USDA Forest Service, Pacific Northwest Research Station, General Technical Report PNW-GTR-736, pp. 35–39. (Portland, OR)
- Gunderson K (2006) Understanding place meanings for wilderness: personal and community values at risk. *International Journal of Wilderness* **12**, 27–31.
- Gunderson K, Watson A (2007) Understanding place meanings on the Bitterroot National Forest, Montana. *Society & Natural Resources* **20**, 705–721. doi:10.1080/08941920701420154
- Hann WJ, Bunnell DL (2001) Fire and land management planning and implementation across multiple scales. *International Journal of Wildland Fire* **10**, 389–403. doi:10.1071/WF01037
- Hesseln H, Loomis J, González-Cabán A, Alexander S (2003) Wildfire effects on hiking and biking demand in New Mexico: a travel cost study. *Journal of Environmental Management* **69**, 359–368. doi:10.1016/J.JENVMAN.2003.09.012
- Hodgson RW (2007) Emotions and sense making in disturbance: community adaptation to dangerous environments. *Human Ecology Review* **14**, 233–242.
- Holmes TP, Abt KL, Huggett RJ Jr, Prestemon JP (2007) Efficient and equitable design of wildfire mitigation programs. In 'People, fire, and forests: a synthesis of wildfire social science'. (Eds TC Daniel, MS Carroll, C Moseley, C Raish) pp. 143–156. (Oregon State University Press: Corvallis, OR)
- Hull RB, Goldstein BE (2006) Barriers to community-directed fire restoration. In 'The public and wildland fire management: social science findings for managers'. (Ed. SM McCaffrey) USDA Forest Service, Northern Research Station, General Technical Report GTR-NRS-1, pp. 77–85. (Newtown Square, PA)
- Jacobson SK, Monroe MC, Marynowski S (2001) Fire at the wildland interface: the influence of experience and mass media on public knowledge, attitudes, and behavioral intentions. *Wildlife Society Bulletin* **29**, 929–937.
- Jakes P, Burns S, Cheng A, Saeli E, Brummel K, Rachel N, Grayzeck S, Sturtevant V, Williams D (2007) Critical elements in the development and implementation of Community Wildfire Protection Plans (CWPPs). In 'The fire environment: innovations, management, and policy, conference proceedings', 26–30 March 2007, Destin, FL. (Eds BW Butler, W Cook) USDA Forest Service, Rocky Mountain Research Station, Proceedings RMRS-P-46CD, pp. 613–624. (Fort Collins, CO)
- Jensen SE (2006) Policy tools for wildland fire management: principles, incentives, and conflicts. *Natural Resources Journal* **46**, 959–1003.
- Kent B, Gebert K, McCaffrey S, Martin W, Calkin D, Schuster E, Martin I, Bender HW, Alward G, Kumagai Y, Cohn PJ, Carroll M, Williams D, Ekarius C (2003) Social and economic issues of the Hayman Fire. In 'Hayman fire case study'. (Ed. RT Graham) USDA Forest Service, Rocky Mountain Research Station, General Technical Report RMRS-GTR-114, pp. 315–395. (Odgen, UT)
- Knotek K, Watson A (2006) Organizational characteristics that contribute to success in engaging the public to accomplish fuels management at the wilderness/non-wilderness interface. In 'Fuels management – how to measure success', 28–30 March 2006, Portland, OR. (Eds PL Andrews, BW Butler) USDA Forest Service, Rocky Mountain Research Station, Proceedings RMRS-P-41, pp. 703–713. (Fort Collins, CO)
- Kumagai Y, Daniels SE, Carroll MS, Bliss JC, Edwards JA (2004) Causal reasoning processes of people affected by wildfire: implications for agency-community interactions and communication strategies. *Western Journal of Applied Forestry* **19**, 184–194.
- Liljeblad A, Watson A, Borrie WT (2009) Determinants of trust on public lands: fire and fuels management on the Bitterroot National Forest. *Environmental Management* **43**, 571–584. doi:10.1007/S00267-008-9230-3
- Liou G, Vogt C, Winter G, McCaffrey S (2008) Residents' values and fuels management approaches. In 'Proceedings of the 2007 northeastern recreation research symposium', 15–17 April 2007, Bolton Landing, NY. (Eds C LeBlanc, C Vogt) USDA Forest Service, Northern Research Station, Proceedings NRS-P-23, pp. 77–83. (Newtown Square, PA)
- Loomis J, González-Cabán A, Englin J (2001) Testing for differential effects of forest fires on hiking and mountain biking demand and benefits. *Journal of Agricultural and Resource Economics* **26**, 508–522.
- Manfredo MJ, Fishbein M, Haas GE, Watson AE (1990) Attitudes toward prescribed fire policies: the public is widely divided in its support. *Journal of Forestry* **88**, 19–23.
- Martin IM, Bender H, Raish C (2007) What motivates individuals to protect themselves from risks: the case of wildland fires. *Risk Analysis* **27**, 887–900. doi:10.1111/J.1539-6924.2007.00930.X
- McCaffrey S (2004a) Thinking of wildfire as a natural hazard. *Society & Natural Resources* **17**, 509–516. doi:10.1080/08941920490452445
- McCaffrey SM (2004b) Fighting fire with education: what is the best way to reach out to homeowners? *Journal of Forestry* **102**, 12–19.
- McCaffrey S (2006) Prescribed fire: what influences public approval? In 'Fire in eastern oak forests: delivering science to land managers, Proceedings of a conference', 15–17 November 2005, Columbus, OH. (Ed. MB Dickinson) USDA Forest Service, Northern Research Station, Proceedings NRS-P-1, pp. 192–198. (Newtown Square, PA)
- McCaffrey S (2008) Understanding public perspectives of wildfire risk. In 'Wildfire risk: human perceptions and management implications'. (Eds WE Martin, C Raish, B Kent) pp. 11–22. (Resources for the Future: Washington, DC)
- McCaffrey S, Moghaddas JJ, Stephens SL (2008) Different interest group views of fuels treatments: survey results from fire and fire surrogate treatments in a Sierran mixed conifer forest, California, USA. *International Journal of Wildland Fire* **17**, 224–233. doi:10.1071/WF07005
- McCool SF, Burchfield JA, Williams DR, Carroll MS (2006) An event-based approach for examining the effects of wildland fire decisions on communities. *Environmental Management* **37**, 437–450. doi:10.1007/S00267-005-0054-0
- McGee TK (2005) Completion of recommended WUI fire mitigation measures within urban households in Edmonton, Canada. *Environmental Hazards* **6**, 147–157. doi:10.1016/J.HAZARDS.2006.05.002
- McGee TK (2007) Urban residents' approval of management measures to mitigate wildland-urban interface fire risks in Edmonton, Canada. *Landscape and Urban Planning* **82**, 247–256. doi:10.1016/J.LANDURBPLAN.2007.03.001
- McGee TK, Russell S (2003) 'It's just a natural way of life...' an investigation of wildfire preparedness in rural Australia. *Global Environmental Change Part B: Environmental Hazards* **5**, 1–12. doi:10.1016/J.HAZARDS.2003.04.001
- Miller C, Landres P (2004) Exploring informational needs for wildland fire and fuels management. USDA Forest Service, Rocky Mountain Research Station, General Technical Report RMRS-GTR-127. (Fort Collins, CO)

- Monroe MC, Nelson KC (2004) The value of assessing public perceptions: wildland fire and defensible space. *Applied Environmental Education and Communication* **3**, 109–117. doi:10.1080/15330150490472781
- Monroe MC, Long AJ, Marynowski S (2003) Wildland fire in the Southeast: negotiating guidelines for defensible space. *Journal of Forestry* **101**, 14–19.
- Monroe M, Nelson KC, Payton M (2006) Communicating with homeowners in the interface about defensible space. In 'The public and wildland fire management: social science findings for managers'. (Ed. SM McCaffrey) USDA Forest Service, Northern Research Station, General Technical Report NRS-GTR-1, pp. 99–109. (Newtown Square, PA)
- Moseley C (2007) Class, ethnicity, rural communities, and the socioeconomic impacts of fire policy. In 'People, fire, and forests: a synthesis of wildfire social science'. (Eds TC Daniel, MS Carroll, C Moseley, C Raish) pp. 171–186. (Oregon State University Press: Corvallis, OR)
- Nelson KC, Monroe MC, Johnson JF (2005) The look of the land: homeowner landscape management and wildfire preparedness in Minnesota and Florida. *Society & Natural Resources* **18**, 321–336. doi:10.1080/08941920590915233
- O'Laughlin J (2005) Policy issues relevant to risk assessments, balancing risks, and the National Fire Plan: needs and opportunities. *Forest Ecology and Management* **211**, 3–14. doi:10.1016/J.FORECO.2005.01.023
- Olsen CS, Shindler BA (2007) Citizen–agency interactions in planning and decisionmaking after large fires. USDA Forest Service, Pacific Northwest Research Station, General Technical Report PNW-GTR-715. (Portland, OR)
- Ostergren DM, Lowe KA, Abrams JB, Ruther EJ (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**, 375–382.
- Parkinson TM, Force JE, Smith JK (2003) Hands-on learning: its effectiveness in teaching the public about wildland fire. *Journal of Forestry* **101**, 21–26.
- Rodriguez-Mendez S, Carroll MS, Blatner KA, Findley AJ, Walker GB, Daniels SE (2003) Smoke on the hill: a comparative study of wildfire and two communities. *Western Journal of Applied Forestry* **18**, 60–70.
- Ryan R, Hamin E (2006) Engaging communities in post-fire restoration: forest treatments and community–agency relations after the Cerro Grande Fire. In 'The public and wildland fire management: social science findings for managers'. (Ed. SM McCaffrey) USDA Forest Service, Northern Research Station, General Technical Report NRS-GTR-1, pp. 87–96. (Newtown Square, PA)
- Ryan RL, Hamin E (2008) Wildfires, communities, and agencies: stakeholders' perceptions of postfire forest restoration and rehabilitation. *Journal of Forestry* **106**(7), 370–379.
- Ryan RL, Wamsley MB, Blanchard BP (2006) Perceptions of wildfire threat and mitigation measures by residents of fire-prone communities in the Northeast: survey results and wildland fire management implications. In 'The public and wildland fire management: social science findings for managers'. (Ed. SM McCaffrey) USDA Forest Service, Northern Research Station, General Technical Report NRS-GTR-1, pp. 11–17. (Newtown Square, PA)
- Shindler B (2007) Public acceptance of wildland fire conditions and fuel reduction practices: challenges for federal forest managers. In 'People, fire, and forests: a synthesis of wildfire social science'. (Eds TC Daniel, MS Carroll, C Moseley, C Raish) pp. 37–54. (Oregon State University Press: Corvallis, OR)
- Shindler B, Toman E (2003) Fuel reduction strategies in forest communities. *Journal of Forestry* **101**, 8–15.
- Shindler BA, Toman E, McCaffrey SM (2009) Public perspectives of fire, fuels, and the Forest Service in the Great Lakes Region: a survey of citizens in Minnesota, Wisconsin, and Michigan. *International Journal of Wildland Fire* **18**, 157–164. doi:10.1071/WF07135
- Shiralipour HJ, Monroe MC, Nelson KC, Payton M (2006) Working with neighborhood organizations to promote wildfire preparedness. In 'The public and wildland fire management: social science findings for managers'. (Ed. SM McCaffrey) USDA Forest Service, Northern Research Station General Technical Report NRS-1, pp. 151–162. (Newtown Square, PA)
- Stankey GH (1976) Wilderness fire policy: an investigation of visitor knowledge and beliefs. USDA Forest Service, Intermountain Forest and Range Experiment Station, Research Paper INT-RP-180. (Ogden, UT)
- Steelman TA (2008) Addressing the mitigation paradox at the community level. In 'Wildfire risk: human perceptions and management implications'. (Eds W Martin, C Raish, B Kent) pp. 64–80. (Washington, DC)
- Steelman TA, Burke CA (2007) Is wildfire policy in the United States sustainable? *Journal of Forestry* **105**, 67–72.
- Steelman TA, Kunkel G, Bell D (2004) Federal and state influence on community responses to wildfire threats: Arizona, Colorado, and New Mexico. *Journal of Forestry* **102**, 21–27.
- Stewart SI, Radeloff VC, Hammer RB, Hawbaker TJ (2007) Defining the wildland-urban interface. *Journal of Forestry* **105**, 201–207.
- Sturtevant V, Jakes P (2008) Collaborative planning to reduce risk. In 'Wildfire risk: human perceptions and management implications'. (Eds WE Martin, C Raish, B Kent) pp. 44–63. (Washington, DC)
- Sturtevant V, McCaffrey SM (2006) Encouraging wildland fire preparedness: lessons learned from three wildfire education programs. In 'The public and wildland fire management: social science findings for managers'. (Ed. SM McCaffrey) USDA Forest Service, Northern Research Station, General Technical Report NRS-GTR-1, pp. 125–136. (Newtown Square, PA)
- Sturtevant V, Moote MA, Jakes P, Cheng AS (2005) Social science to improve fuels management: a synthesis of research on collaboration. USDA Forest Service, North Central Research Station, General Technical Report NC-GTR-257. (St Paul, MN)
- Sutton J, Palen L, Shklovski I (2008) Backchannels on the front lines: emergent uses of social media in the 2007 Southern California wildfires. In '5th International Conference on Information Systems for Crisis Response and Management ISCRAM2008', 5–7 May 2008, Washington, DC. (Eds F Fiedrich, B Van de Walle) pp. 624–631. (ISCRAM) Available at http://www.iscram.org/dmdocuments/ISCRAM2008/papers/ISCRAM2008_Sutton_et_al.pdf [Verified 4 July 2012]
- Taylor JG, Mutch RW (1986) Fire in wilderness: Public knowledge, acceptance, and perceptions. In 'Proceedings for the national wilderness research conference: current research'. (Ed. RC Lucas) USDA Forest Service, Intermountain Research Station, General Technical Report INT-GTR-212, pp. 49–59. (Ogden, UT)
- Taylor JG, Gillette SC, Hodgson RW, Downing JL, Burns MR, Chavez DJ, Hogan JT (2007) Informing the network: improving communication with interface communities during wildland fire. *Human Ecology Review* **14**, 198–211.
- Thapa B, Holland SM, Absher JD (2004) The relationship between wildfires and tourist behaviors in Florida: An exploratory study. In 'Proceedings of the 4th social aspects and recreation research symposium', 4–6 February 2004, San Francisco, CA. (Eds PT Tierney, DJ Chavez) pp. 154–161. (San Francisco State University: San Francisco)
- Toman E, Shindler B (2006) Communicating the wildland fire message: influences on knowledge and attitude change in two case studies. In 'Fuels management – how to measure success, Conference proceedings', 28–30 March 2006, Portland, OR. (Eds PL Andrews, BW Butler) USDA Forest Service, Rocky Mountain Research Station, Proceedings RMRS-P-41, pp. 715–728. (Fort Collins, CO)
- Toman E, Shindler B, Brunson M (2006) Fire and fuel management communication strategies: citizen evaluations of agency outreach activities. *Society & Natural Resources* **19**, 321–336. doi:10.1080/08941920500519206

- Toman E, Shindler B, Olsen C (2008a) Communication strategies for post-fire planning: lessons learned from forest communities. In 'Fire social science research from the Pacific Southwest Research Station: studies supported by National Fire Plan Funds'. (Eds DJ Chavez, JD Absher, PL Winter) USDA Forest Service. Pacific Southwest Research Station, General Technical Report PSW-GTR-209, pp. 165–179. (Albany, CA)
- Toman EL, Shindler B, Absher J, McCaffrey S (2008b) Post-fire communications: The influence of site visits on local support. *Journal of Forestry* **106**, 25–30.
- Vaske JJ, Absher JD, Bright AD (2007) Salient value similarity, social trust and attitudes toward wildland fire management strategies. *Human Ecology Review* **14**, 223–232.
- Vining J, Merrick MS (2008) The influence of proximity to a National Forest on emotions and fire-management decisions. *Environmental Management* **41**, 155–167. doi:10.1007/S00267-007-9041-Y
- Walker SH, Rideout DB, Loomis JB, Reich R (2007) Comparing the value of fuel treatment options in northern Colorado's urban and wildland-urban interface areas. *Forest Policy and Economics* **9**, 694–703. doi:10.1016/J.FORPOL.2006.06.001
- Weible C, Sabatier P, Nechodom M (2005) No sparks fly: policy participants agree on thinning trees in the Lake Tahoe Basin. *Journal of Forestry* **103**, 5–9.
- Weisshaupt BR, Carroll MS, Blatner KA, Robinson WD, Jakes PJ (2005) Acceptability of smoke from prescribed forest burning in the northern inland west: a focus group approach. *Journal of Forestry* **103**, 189–193.
- Weisshaupt BR, Jakes PJ, Carroll MS, Blatner KA (2007) Northern inland west land/homeowner perceptions of fire risk and responsibility in the wildland–urban interface. *Human Ecology Review* **14**, 177–187.
- Williamson MA (2007) Factors in United States Forest Service district rangers' decision to manage a fire for resource benefit. *International Journal of Wildland Fire* **16**, 755–762. doi:10.1071/WF06019
- Winter G, Fried JS (2000) Homeowner perspectives on fire hazard, responsibility, and management strategies at the wildland–urban interface. *Society & Natural Resources* **13**, 33–49. doi:10.1080/089419200279225
- Winter GJ, Vogt C, Fried JS (2002) Fuel treatments at the wildland-urban interface: common concerns in diverse regions. *Journal of Forestry* **100**, 15–21.
- Winter G, Vogt CA, McCaffrey S (2004) Examining social trust in fuels management strategies. *Journal of Forestry* **102**, 8–15.
- Winter G, Vogt C, McCaffrey S (2006) Residents warming up to fuels management: homeowners' acceptance of wildfire and fuels management in the WUI. In 'The Public and wildland fire management: social science findings for managers'. (Ed. SM McCaffrey) USDA Forest Service, Northern Research Station, General Technical Report NRS-GTR-1, pp. 19–32. (Newtown Square, PA)
- Zaksek M, Arvai JL (2004) Toward improved communication about wildland fire: mental models research to identify information needs for natural resource management. *Risk Analysis* **24**, 1503–1514. doi:10.1111/J.0272-4332.2004.00545.X