Patterns of preference and practice: bridging actors in wildfire response networks in the American Northwest

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The roles of bridging actors in emergency response networks can be important to disaster response outcomes. This paper is based on an evaluation of wildfire preparedness and response networks in 21 large-scale wildfire events in the wildland–urban interface near national forests in the American Northwest. The study investigated how key individuals in responder networks anticipated seeking out specific people in perceived bridging roles prior to the occurrence of wildfires, and then captured who in fact assumed these roles during actual large-scale events. It examines two plausible, but contradictory, bodies of theory—similarity and dissimilarity—that suggest who people might seek out as bridgers and who they would really go to during a disaster. Roughly one-half of all pre-fire nominations were consistent with similarity. Yet, while similarity is a reliable indicator of how people expect to organise, it does not hold up for how they organise during the real incident.

Introduction: networks in disasters

The roles of bridging actors in emergency response networks can be important to disaster response outcomes (Kapucu, 2006; Nowell and Steelman, 2014). Bridging actors connect portions of a network that otherwise might be disconnected, enabling information and resources to flow from one part to another. This flow of information has been identified as critical to effective incident response (Steelman et al., 2014), but currently there is a dearth of empirical literature on the efficacy of these bridging actors. Developing the theoretical and practical knowledge that informs these relationships is vital to the longer-term effectiveness of disaster response.

This paper is based on a study of wildfire preparedness and response networks in 21 large wildfires conducted from summer 2012 through autumn 2013 in counties in the wildland–urban interface (WUI) near national forests in Idaho, Montana, Oregon, and Washington, United States. One would expect different segments of a wildlife response network (such as animal services, citizen groups, fire service, land management, law enforcement, and local, state, and federal government) to coordinate more effectively if multiple bridging actors connected these segments. This study investigated how key individuals in responder networks anticipated seeking out specific people in perceived bridging roles prior to the occurrence of wildfires, and then captured who in fact assumed these roles during actual large-scale events.

It facilitates an exploration of the extent to which people's preferences for bridging actors approximated who actually played these roles in 21 different incident response networks. By understanding who people anticipated seeking out and then identifying who really played the role, the study permits more realistic planning for effective disaster response and contributes to understanding of the critical relational dynamics that remain central to disaster scholarship across multiple disciplines (McEntire, 2007).

Entanglements and emergent networks in incident response

Wildfire has been recognised as a hazard in the American West since the earliest European settlements (Pyne, 2001; Carroll et al., 2006). In many ways, wildfires are exemplary of the types of human–environment relationships that have led many social scientists to question the extent to which environmental disasters can be considered as 'natural'. While the wilderness of the US and the conditions affecting fire susceptibility are the products of centuries of human activity that intensified with the westward expansion of European settlements (Anderson, 2006; Lightfoot et al., 2013), fires burning on wildlands frequently are vital to the ecological processes that sustain these natural systems. The potential for disaster arises when they spread to the intersection of wildland and human settlements, commonly referred to as the WUI. Importantly, it is not only wildfires that spread to human settlements; there has been a significant rise in recent decades in the number of human settlements in fire-prone wildland—an increase of 52 per cent between 1970 and 2007 (Theobald and Romme, 2007; see also Schoennagel et al., 2009). Moreover, the risk of wildfire disasters has mounted with anthropogenic climate change, which has contributed to an augmentation in the size and intensity of wildfires (Brown, Hall, and Westerling, 2004; Running, 2006).

The management of federal lands has long involved competing interests, with the tensions between various local groups, indigenous peoples, and federal land agencies characterised as 'collisions of worlds' (Anderson, 2006), especially in the American West. These issues have been reviewed extensively (Fedkiw, 1998; Krannich and Smith, 1998; Cuthane, 1981), with scholars noting that stakeholder groups have competing agendas vis-à-vis the management, consumption, and conservation of federal land resources (Fleming, McCartha, and Steelman, 2015). All of these stakeholders are dependent to differing degrees on a common set of natural resources, linking them via this mutual dependence. Although a number of stakeholders occasionally form cross-cutting alliances in advocating for particular land and fire management policies and strategies (McCarthy, 2002; Walker, 2003), the tensions and historical relations between these groups and organisations are particularly salient during large-scale wildfire response, often because of matters of jurisdiction, trust, and insider–outsider frictions (Carroll et al., 2004, 2006). Hence, the production of wildfire risk by human activity—combined with the historical tensions and entanglements

concerning natural resource management, and the legitimacy of different agencies and stakeholder groups in the American West—has the cumulative effect of introducing relational dynamics as a core element of incident complexity, which makes the question of network bridging particularly salient in wildfire response.

The responder network has been defined as 'the collection of individuals, organizations, and agencies that have sustained involvement during the event who aim to serve the community in minimizing and coping with damages brought on by the disaster' (Nowell and Steelman, 2014, p. 235). While the network is ostensibly populated by organisations guided by impersonal rules, the organisations themselves are staffed by human subjects whose historical relations and perceptions come to bear in the practice of response. In a large wildfire response network, relational dynamics are critical elements that can be characterised by relationship complexity along with the competing interests of key stakeholders, thus making the need for bridging ties relatively important. Interaction and communication patterns in response networks are more emergent than programmed (Choi and Brower, 2006), yet they are not independent of previous institutional arrangements (Nowell and Steelman, 2014). Importantly, breakdowns in communication in one area of response networks have the potential to spawn cascading failures in other areas (Nowell and Steelman, 2014).

Since communication issues can result in problematic and potentially dangerous outcomes, there is an urgent need for research that can go beyond identifying barriers to effective network performance and begin to pinpoint actions and roles that can surmount these obstacles. Response networks in large wildfires are composed of local actors—emergency management and law enforcement, fire service, and sheltering agencies—and non-local actors—federal or state wildfire responders who may or may not be familiar with the region in which they work (Nowell and Steelman, 2014). The crisis-borne necessity of having local and non-local actors work together can create considerable tension, if not conflict. In their case studies of wildfire response in the American West, Carroll et al. (2006) found that a lack of mechanisms for bringing together the different orientations present in the response network resulted in disruptions in local interactions and increased conflict. Incident management teams (IMTs), which provide a paramilitary management infrastructure for the logistical coordination of federal, local, and state emergency responders and governmental and non-governmental agencies, are granted unusual levels of authority and are not necessarily beholden to local power structures and relationships (Carroll et al., 2006). Moreover, people in disaster-affected communities 'often think the rules and regulations of public safety and helping organizations are another intrusion into their already disrupted lives' (Carroll et al., 2006, p. 262). The Incident Command System—the organisational strategy for emergency response operations under the US National Incident Management System— sometimes is seen by local communities as a gap-creating process that inhibits community action in emergencies (Carroll et al., 2006). This paper examines some of the factors that might affect the bridging of these network gaps.

Bridges in wildfire response networks: trust, homophily, and embeddedness

Bridging actors connect disconnected actors and groups in a given network. Bridging processes entail fundamentally working across boundaries—specialisation, organisational, sectoral, scalar, and often geographic. Information-sharing is associated with increased learning capacity in partnerships (Manring, 2007) and cooperation can be more effective if there are ties that span multiple boundaries of geography, expertise, and ideology (Schneider et al., 2003). Actors who serve as bridges in networks, connecting different subgroups, have proven critical in facilitating the flow of information and influence (Burt, 1992; Kapucu, 2006) and have access to more diverse resources beyond their organisation, group, or jurisdiction than do other members of the network (Bodin, Crona, and Ernstson, 2006).

Two broad theoretical frameworks support different expected outcomes relating to who people might prefer as bridgers and who might actually fulfil these roles during a disaster (see Table 1 for a summary). The literature related to trust and familiarity suggests that people would likely see those with whom they are familiar and whom they trust as ideal bridgers in these situations (Powell et al., 2005; McCaffrey et al., 2013). Perceptions of who could and should play bridging roles are situated and based on, among other things, historical relations (Bryson, Crosby, and Middleton Stone, 2006), trust (Perrone, Zaheer, and McEvily, 2003; Lundin, 2007), homophily (Burt, 1992), and relational embeddedness (Nowell and Steelman, 2014). In an emergency, people tend to trust and act on messages that come from familiar sources, but those sources are not necessarily the most useful (Fitzpatrick and Mileti, 1991; Steelman et al., 2014; Velez et al., forthcoming).

Alternatively, the literature from policy (John and Christopher, 2000), administration (Steelman et al., 2012), environmental studies (Schultz, 2011; Heberlein, 2012), and organisational studies (Milward and Provan, 2000) points to several reasons why there might be a low correspondence between pre-incident preferences and the actual composition of networks during a wildfire incident. Nowell and Steelman

Table 1. Similarity and dissimilarity theses

Similarity thesis	Dissimilarity thesis
• People will likely see those with whom they are familiar, who are similar to themselves (homophily), and whom they trust as ideal bridgers during a disaster. • These preferences are important and can help outsiders connect better to locals, but high levels of preference for similarity can impede network bridging.	• There will be a low correspondence between pre-incident preferences and the actual composition of networks during wildfire incidents. • This is the result of novel and emergent network configurations in emergencies and operational priorities that override bridging priorities in some agencies. • These factors may curtail the problems associated with high levels of preferences for similarity, but excessive dissimilarity could also negatively affect network performance.

Source: authors.

(2014) shed preliminary light on this question in the context of communication networks, finding that relational embeddedness was a stronger predictor of communication networks during disasters relative to institutional embeddedness. However, there is no known research to date that assesses this question in the context of positions of brokerage. These unresolved tensions in the literature make a compelling case for empirical work to bring clarity to the theoretical literature, as well as to provide insight into practical action.

The similarity thesis: trust, homophily, and relational embeddedness

Trust is an important component in building relationships. In their review of 64 articles published between 2000 and 2008 on public acceptance of fire and fuel management, McCaffrey et al. (2013, p. 16) found that the two variables most commonly identified as increasing acceptance of procedures were familiarity with techniques and trust in people implementing the procedures. Burt (1992) established a direct connection between trust and homophily—a sociological principle that holds that people who have similar characteristics are more likely to interact with each other than people who are dissimilar (McPherson, Smith-Lovin, and Cook., 2001). A sizable body of empirical research has identified homophily as a core relational variable underwriting the formation of groups and organisations (McPherson, Smith-Lovin, and Cook, 2001; Petev, 2013), facilitating effective communication (Rogers, 2003), and the growth of inter-organisational collaboration (Powell et al., 2005). In addition, there is a wealth of empirical evidence that suggests that shared ties to organisations and collectives (Frank, 2009) or ideologies (Anderson, 1983) serve as powerful proxies for homophily in facilitating communication, interaction, and relationships.

Nowell and Steelman (2014) studied networks and interaction in three large wildfires in the American Southwest. They were interested in the extent to which two different types of embeddedness—relational and institutional—helped to predict frequency and the quality of interaction among responders during large WUI wildfires. In their model, relational embeddedness referred to the extent to which individual responders had direct, personal relations prior to the incident, whereas institutional embeddedness referred to the extent to which individuals had shared affiliations or roles. They found that both factors contributed to higher frequency of and/or improved interaction in emergent response networks, but relational embeddedness (familiarity) played a stronger part than did institutional embeddedness (similarity). In a finding consistent with the homophily principle, institutionally embedded actors were more likely to interact with one another during wildfire incidents, but this was not associated with less problematic communication (Nowell and Steelman, 2014, pp. 17–18). Specifically, they found that those with institutional embeddedness but no relational embeddedness were more likely to experience problematic communication; that is, perceived similarity when not tempered by personal familiarity was associated with more problematic communication.

The dissimilarity thesis: why one might see differences in anticipated versus actual bridgers

Bridging actors not only connect those who are disconnected, but also they are more likely than others to connect *dissimilar* actors and organisations (Coser, 1975, p. 257; Granovetter, 1982, p. 108). The multiple cultural, functional, jurisdictional, and social differences in disaster response networks in many ways require some degree of bridging to facilitate coordinated action across pre-existing divisions. Thus, a universal tendency towards homophily might conceivably be counterproductive, as bridging is counter to the emergent concretisation of boundaries one might expect from high levels of homophilic preferences.

There are, however, four key reasons why one might expect differences in anticipated versus actual bridgers in wildfire incidents. First, it is known that plans that outline what responders expect to happen during an incident frequently do not reflect what *actually* occurs (Choi and Brower, 2006; Kapucu, 2006). This finding has opened up an important area of inquiry into the relationship between preferences and expectations in advance of an incident and the realities of what takes place during one. To date, progress on this research agenda has been modest. Choi and Brower (2006), for instance, found significant decoupling between formalised plans for who *should* be the primary point of contact for a given emergency response function and responder expectations about who they *would likely* go to during an incident. However, to date, no study has looked at whether those who are most trusted to fill the role ahead of an incident reflects who actually does so during an event.

Second, in complex networks, it is highly unlikely that any single actor or organisation will meet all needs and expectations as a bridging actor (John and Christopher, 2000). Different actors in a network might exhibit different or even conflicting preferences for who should occupy such roles; hence, members of Group 1 may prefer bridging Actor A when collaborating with Group 2, whereas Group 2 may prefer bridging Actor B. The complexity of this scenario mounts markedly with increased network size, as with wildfire response networks composed of emergency responders, law enforcement personnel, officials from local, federal, and state agencies, and members of federal land agencies (such as the US Bureau of Land Management and the US Forest Service (USFS)), IMT personnel, and representatives of the media. In other words, as the network gains more members, and as there is more overlap in responsibility within the network, it becomes more likely that different groups will prefer different bridging actors. Identifying effective bridging actors, therefore, often is complex, and pre-incident expectations do not always match the features and structure of an emergent, incident-based network.

Third, although trust may be a core variable in explaining the preference for some bridging actors over others, operational factors come into play as well. John and Christopher (2000), for instance, claim that organisations tasked with directly managing programmes are not likely to be effective intermediaries in network cooperation. For example, fire service agencies have very specific and time-sensitive

responsibilities to fight wildfire or to protect structures and populations in the WUI and consequently simply might not have the time and wherewithal to assume key leadership functions in facilitating coordination with IMTs and the greater incident response network. In contrast, Milward and Provan (2000) studied governing networks of public agencies, specifically comparing and contrasting four contracted non-profit systems that offered mental health services in communities across the US (see also Provan and Milward, 2001). They found that organisations that produced at least some of the services in the system were more effective at governing a set of providers than principals that governed but did not have any kind of operational role.

Fourth, when anticipating what one would do in a disaster, attitudes may differ from behaviour because individuals are (frequently quite suddenly) enmeshed in a completely different social network during the disaster than before it. People may have attitudinal preferences for courses of action, but a wealth of mitigating factors may contribute to a behavioural divergence from those attitudes (Schultz, 2011; Heberlein, 2012). As it stands, there is a dearth of empirical research on the divergence of attitude and behaviour in the context of disaster response networks. One exception is a study by Steelman et al. (2012) who surveyed 873 residents in five large wildfire settings in the American West in 2009 and 2010 to explore the types of information that people want, trust, and use during a wildfire. They found that the sources that were utilised prior to the events were correlated positively with the sources employed during the fires, but that there were significant gaps between sources used and sources that were perceived as most useful or trustworthy. This underscores the earlier point that it is reasonable to expect a lack of correspondence between preferred and actual bridging ties, and such incongruence could have important implications for response network performance.

Methodology

Data for this study were drawn from a larger longitudinal study of factors that influence incident response to wildfires in the American West.[2] This paper concerns data collected at two time points. First, to assess the correspondence between preferred and actual bridging ties in wildfire incidents, we captured initially the actors and organisations viewed by local government and incident response agencies as ideal bridging actors in large wildfires involving IMTs prior to the 2013 wildfire season. Second, we ascertained the types of actors and organisations identified by local government and incident response agencies as having performed the roles of bridging actors in 21 large wildfires in the study region. Next, we compared the pre-fire season findings with the during-fire season findings to pinpoint and explain patterns of correspondence and differences in pre-fire ideals and actual incident roles. Finally, we explored patterns in the types of actors and organisations that were highlighted by different respondent groups.

Data and sample

Pre-fire survey

We conducted a survey of county/municipal disaster response agency leaders from 109 counties determined as at-risk of wildfire in Idaho, Montana, Oregon, and Washington in the autumn/winter of 2012–13. These local agencies included responders such as animal rescue, the American Red Cross, county offices of emergency management (OEMs), county sheriffs, and fire departments, as well as local government offices, such as county commissioners, mayor's offices, and municipal and county administrators. We contacted a total of 1,801 individuals and subsequently received 706 surveys, resulting in a response rate of 45 per cent (n=654) at the organisation level, and 39 per cent at the individual level, which is consistent with web-based survey response rates (cf. Baruch and Holtom, 2008). Non-response analysis indicated that this sample over-represented the fire service (44 per cent) and municipal government (20 per cent) and under-represented the county government (12 per cent), law enforcement (8 per cent), and animal services (4 per cent). Furthermore, county OEMs were under-represented (12 per cent), but unlike other agency types, there was only one OEM office per county and the OEM response rate (64 per cent) was more than 20 per cent higher than any other category.

Post-fire survey

A total of 21 significant fire events occurred in the pre-fire survey sample region during summer 2013. We invited organisations from all counties that participated in the pre-fire survey that experienced a significant fire event that threatened human populations[3] during summer 2013 to take part in a post-fire survey in early autumn 2013 and sent surveys to all agency leaders who were actively involved in incident response. Ultimately, we identified a total of 329 organisations or units (such as USFS districts) and 805 individuals for all 21 incidents. The final response rate was 60 per cent at the organisation level (n=196) and 58 per cent at the individual level (n=478). For this study, we included only local responders from those 19 counties that were part of the pre- and post-fire samples, decreasing the total number of agencies to 134 and total respondents to 159 for both samples combined. Non-response analysis indicated that county OEM, county government, fire service, law enforcement, and state government constituted 67 per cent of the post-fire survey sample, whereas all others combined represented less than 33 per cent.

Measures

Trusted community bridgers before a fire

To locate potential bridging actors in pre-fire responder networks, we analysed first which actors and organisations different members of a potential response network were likely to trust. As part of the pre-fire survey, we asked leaders the following question:

During a large-scale wildfire event, Type I or Type II Incident Management Teams (IMT) are often brought in from outside the area to manage the incident and may have limited local knowledge. Imagine an IMT has arrived and requested that one person be assigned to the IMT who could serve as a community liaison. The role of the community liaison would be to help inform the IMT about local conditions, contacts, priorities, culture, and politics.

1. *Is there a person in your community or within the local USFS that you would trust to play this role? (Yes/No)*

2. *If yes, in the spaces below, please list the titles of up to three people and their associated organisation/agency (if applicable) that you feel would be the best person to serve as a community liaison to an incident management team from outside the area.*

Actual community bridgers during a fire

The post–fire survey elicited data on a range of variables, including multiple aspects of network interaction and performance during the incident. This study focused on two open–ended questions on bridging actors active during the event, put to all respondents:

Over the course of the incident, were there one or more local individuals within the USFS or other host and co-operator agencies that were particularly helpful to you in understanding how to work most effectively with an IMT? If yes, please list them below. [IMT bridge]

Over the course of this incident, were there local individuals within the USFS or other host and co-operator agencies who took a leadership role in helping to maintain effective communication and coordination among the different agencies/organisations? If yes, please list them below [Network leader]

Coding types of agencies

The resulting database consisted of 244 *pre-fire* nominations of trusted bridgers from 102 respondents in 19 counties. It also included 117 nominations of actual bridgers to the IMT and 79 nominations of network leaders in actual events during the 2013 fire season.

The first stage of analysis was to code each agency in the response networks according to organisation type (such as county OEM, municipal government, and federal land agency)—Table 2 contains a full list of agency types and nominations collected from each type for our surveys. We then applied these codes to the organisational affiliations of individuals nominated as bridges in the pre- and post-fire surveys. Using a standard network analysis format, we linked characteristics of nominators and nominees for both pre- and post-fire nominations in the database to evaluate patterns in who nominated whom.

Table 2. Total nominations from each agency type

Nominating agency type	Pre-fire IMT liaison nominations	Incident-based IMT liaison nominations	Incident-based network leader nominations
Animal services	8	0	0
County OEMs	29	13	9
County governments	17	13	6
Fire service	102	40	33
Law enforcement bodies	19	19	17
Municipal governments	69	3	1
Human services (such as the American Red Cross, emergency medical technicians, and hospitals)	*	10	13
Federal land agencies	*	**	**
Landowners	*	7	0
State governments	*	**	**
State land agencies	*	8	0
Miscellaneous non-governmental organisations	*	4	0
Utilities	*	0	0
Total	**244**	**117**	**79**

Notes: * Not surveyed—included only for reference to agency type; ** Survey responses excluded from present analysis for comparability with pre-fire sample.
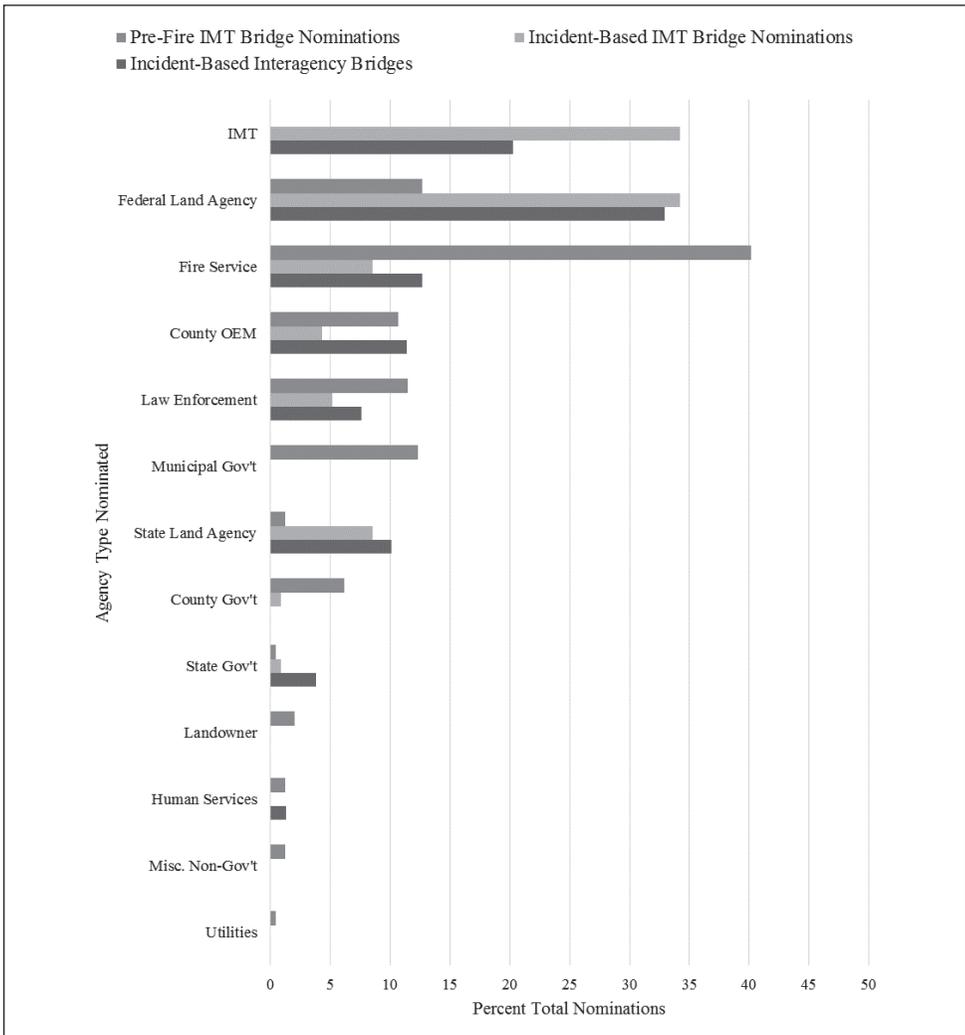**Source:** authors.

Findings

Which agencies were most trusted ahead of the fire season to bridge between local responders and federal outsiders?

Figure 1 displays nomination rates per organisation type for pre-fire nominations for IMT bridge liaisons, incident-based IMT bridge liaisons, and incident-based inter-agency bridges. When looking at these results, it is important to remember that pre-fire nominations were to identify individuals in their community or within the local USFS whom they would trust to bridge between the local and federal (IMT) responders. For pre-fire bridge liaison nominations, individuals in professional fire service roles were nominated most frequently by far, with 40 per cent of all nominations. The second most frequently nominated agency types, federal land agencies and municipal governments, received 13 and 12 per cent of total nominations, respectively, followed closely by law enforcement bodies and county OEMs. All others (such as local landowners, human services, and state land agencies) together received only 13 per cent of nominations combined. Many respondents seemed to put their trust in county leaders. Although

Figure 1. Agency nominees for pre-fire IMT liaisons, incident-based IMT liaisons, and incident-based interagency bridges

locally-based federal land agencies were the second most frequently nominated agency types in the pre–fire survey, local agencies, when taken together (fire service, human services, landowners, municipal and county governments, and OEMs), accounted for 84 per cent of all nominations of trusted bridgers ahead of the 2013 fire season.

Which agencies bridged between local responders and federal outsiders during the 2013 fire season?

Post–fire respondents were asked whether there were one or more local individuals within the USFS or other host and co–operator agencies that were particularly helpful

to them in understanding how to work most effectively with an IMT over the course of the event. Overwhelmingly, the most frequently nominated agency types to serve as bridges to the IMT during wildfires were individuals with federal land agencies (34 per cent). An equal percentage of nominations pertained to non-bridging ties directly to IMT personnel. Individuals in other types of entities each received less than 10 per cent of nominations and a total of 32 per cent of nominations combined.

Which agencies emerged in promoting coordination among the responder network during the 2013 fire season?

The types of agencies nominated as interagency bridges were similar to those nominated as IMT bridges. When respondents were asked whether there were local individuals within the USFS or other host and co-operator agencies who assumed a leadership role to help maintain effective communication and coordination among the different agencies and organisations responding to an event, a total of 79 nominations were received. While the order of nominations differs somewhat, the top six were the same as those for bridges to IMTs. As with the latter, nominations for interagency bridges were most frequently for individuals in federal land agencies (33 per cent), followed by individuals in IMT roles (20 per cent). Nominations for individuals in fire services were the third most common type (13 per cent), followed by county OEM (11 per cent) and state land agencies (10 per cent). Other agency types received less than 10 per cent of total nominations.

Who trusts whom to serve as a bridger?

The study was concerned with examining whether there were patterns in the types of agencies nominated by different respondent agencies. To do so, we generated a network graph of agency nominators and nominees (see Figure 2). In total, 45 per cent of respondents nominated bridges from the same agency type as their own in the pre-fire survey, indicating a relatively high tendency towards homophily in bridging actor preferences and trust (shown as loops in Figure 2). Interestingly, of the 244 pre-fire nominations, 53 per cent (n=130) of them specified a person's name for the liaison they were nominating, indicating that they had some degree of personal familiarity—or relational embeddedness (Nowell and Steelman, 2014)—with nominees. Fire service and municipal governments most frequently nominated IMT liaisons within their own respective agencies, although one can see that county government, county OEM, and law enforcement personnel also nominated agencies within their own type, albeit to a lesser extent. The most central agency types in the network—county government, fire service, and law enforcement—are those that received the overall greatest number of ties. Looking at the diversity of nominating agencies (shown by node size), though, one can see that county OEM and federal land agencies were perceived and trusted as bridging actors by a notable range of agency types, yet their overall frequency of nomination was less than the more central agencies.

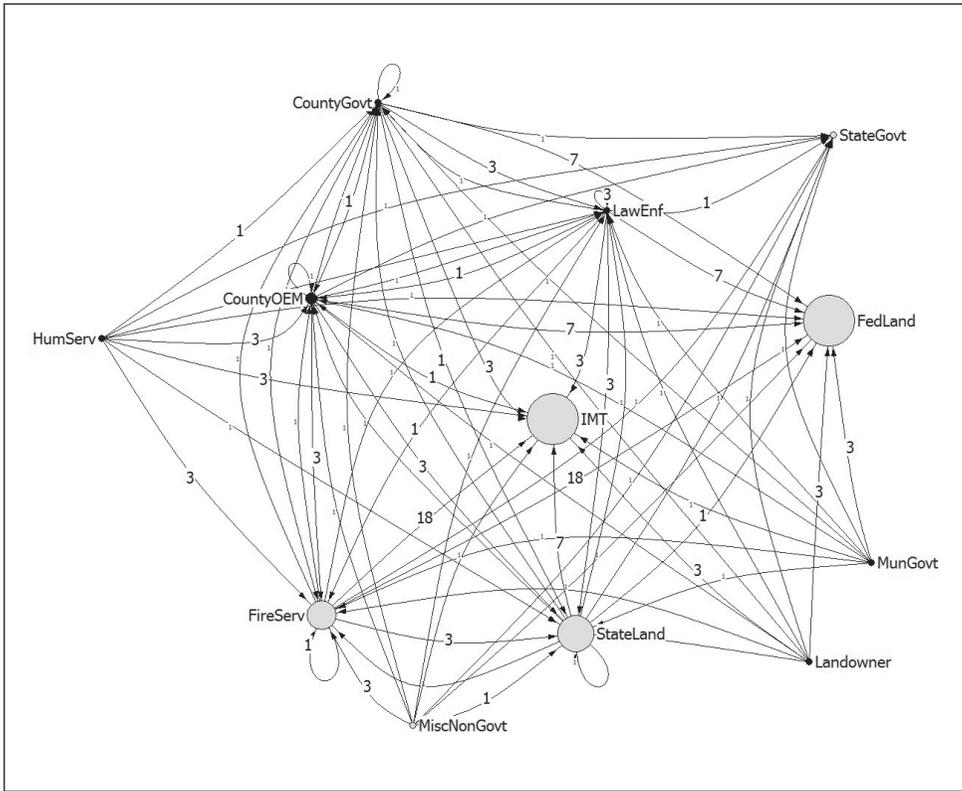**Figure 2.** Network graph of IMT liaison nominations prior to the fire season
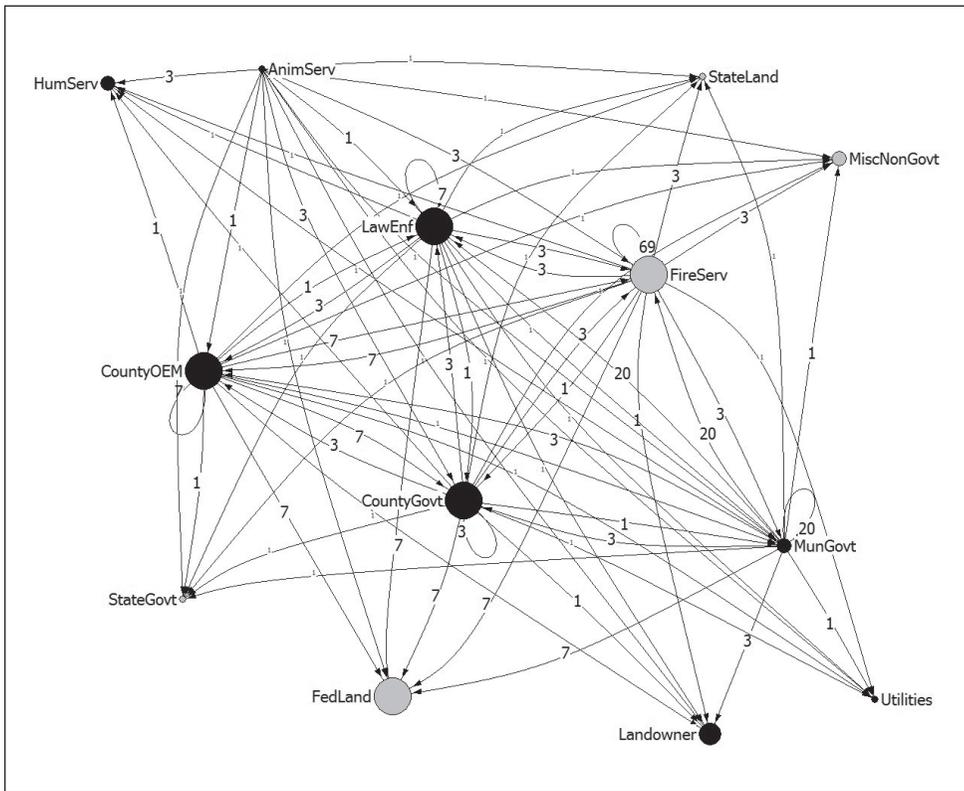
Notes: arrows indicate the direction of nominations; size indicates the number of agency types nominating (0–1, 2, 3, 5); line numbers indicate the number of nominations from sending agency type to receiving agency type (dyadic); centrality is the overall number of ties; and black agency types are local and grey agency types are supra-local or mixed local–supra-local.

Source: authors.

Who was a bridge for whom during the incident?

Figure 3 is a network graph of agency type nominators and agency types nominated as having served as intermediaries between nominators and IMTs in their respective wildfire incidents. Overall, only three per cent of respondents named bridging actors from their own agency type, indicating a much lower tendency towards homophily than in the pre-fire nominations (45 per cent). One noteworthy pattern in the incident-based IMT bridge nominations is the low level of bridging in the network overall (indicated by the centrality and diversity of direct ties to IMTs). Another notable pattern is the increased centrality and diversity of bridging ties through federal land agencies. Agency types previously central to the pre-fire nomination network—county government, fire service, and law enforcement—were decidedly marginal as bridging actors in the incident-based networks. One can see, too, that state land agencies emerged as more central and frequent bridging agencies during wildfire incidents.

A.J. Faas, Anne-Lise K. Velez, Clare FitzGerald, Branda L. Nowell, and Toddi A. Steelman

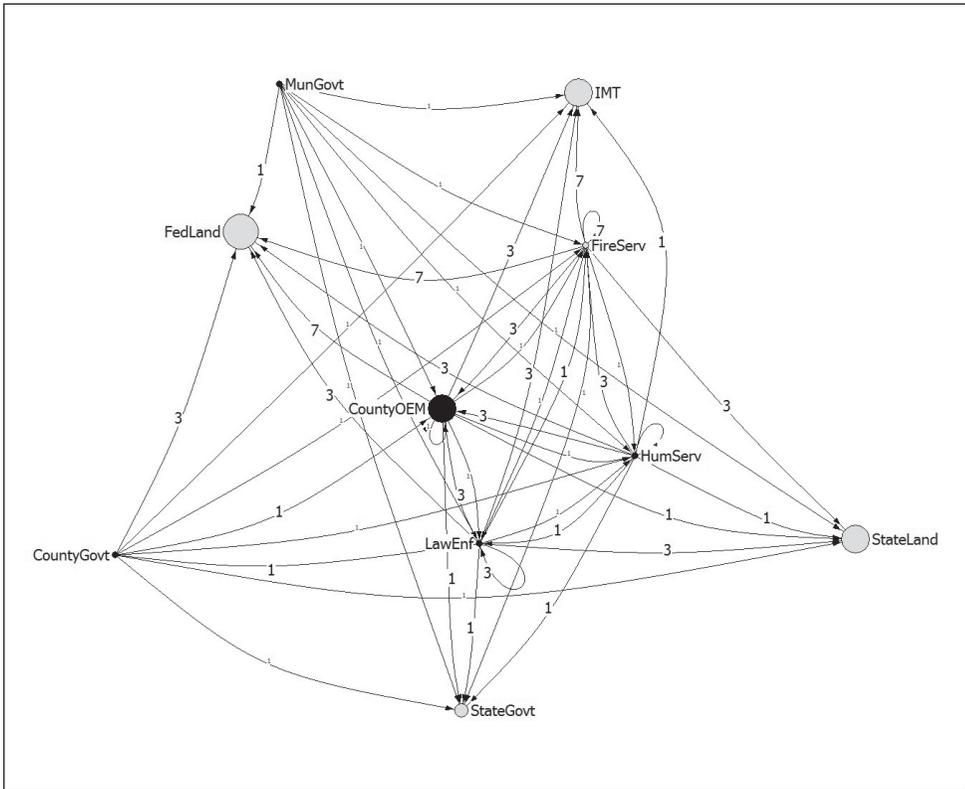**Figure 3.** Network graph of IMT bridges during wildfire incidents

Notes: arrows indicate the direction of nominations; size indicates the number of agency types nominating (0–1, 2, 3, 5); line numbers indicate the number of nominations from sending agency type to receiving agency type (dyadic); centrality is the overall number of ties; and black agency types are local and grey agency types are supra-local or mixed local–supra-local.

Source: authors.

Who was viewed as a network leader and by whom during the incident?

Next, we identified patterns of agency type nominations by respondents from each agency type in the sample (see Figure 4). Overall, seven per cent of interagency bridges were from the same agency type as the respondents (slightly higher homophily than IMT bridges during the fire, but still much lower than the 45 per cent of pre-fire nominations). Homophilic nominations came primarily from the fire service and law enforcement, with one from within human services. Here one can see that county OEM emerged as the most central agency type, although OEM offices themselves principally identified federal land agencies as network leaders and federal land agencies were nominated by a greater range of agency types than was the case for OEMs (designated by node size). Interestingly, IMTs were less central and enjoyed less diversity with respect to nominations as network leaders than they did as direct ties to agencies in the network in the IMT nominations. Finally, state land agencies retained a noticeable degree of centrality and diversity in both incident-based networks.

Figure 4. Network graph of interagency bridges during wildfire incidents

Notes: arrows indicate the direction of nominations; size indicates the number of agency types nominating (0–1, 2, 3, 5); line numbers indicate the number of nominations from sending agency type to receiving agency type (dyadic); centrality is the overall number of ties; and black agency types are local and grey agency types are supra-local or mixed local–supra-local.

Source: authors.

Discussion

We noted earlier that there are two plausible, but contradictory, bodies of theory that suggest whom people might seek out as bridgers and whom they would actually turn to in a disaster. The evidence of this study generally supports both expectations while demonstrating an interesting dynamic between the two tendencies. Overall, pre-fire nominations for IMT liaisons were consistent with the similarity thesis that in a pre-fire scenario respondents would be more likely to name those who were more similar to themselves. The three most commonly nominated agency types—fire service, federal land agencies, and law enforcement—are arguably intuitive selections as leaders in wildfire emergency response. Roughly one-half of all pre-fire nominations were consistent with the similarity thesis, or homophily (McPherson, Smith-Lovin, and Cook, 2001; Petev, 2013), and relational embeddedness (familiarity) (Nowell and Steelman, 2014), both of which are consistently associated with trust and the formation of social groups (Burt, 1992). However, while similarity and familiarity

appear to be reliable indicators of how people expected to organise in an emergency, this did not hold up for actual incident network performance in the cases examined.

The most noteworthy finding in this study is the difference in pre- and post-fire nominations for IMT bridges. Notably, fire service personnel were overwhelmingly favoured in pre-fire nominations, followed by federal land agencies, municipal governments, and law enforcement as distant seconds. The incident-based survey, though, revealed that locally-based federal land agencies were by far the most commonly nominated bridging actors (34 per cent). This is an important distinction, since it shows that the agencies most frequently trusted and expected to play a bridging role (fire service) did not actually fulfil this in practice. Instead, it was one of the least trusted agencies (local federal land agencies) that did so.

Interestingly, the rate of direct (that is, non-bridging) ties to IMTs (34 per cent) was equal to that of locally-based federal land agencies, indicating that IMTs engaged in a fair amount of direct coordination with a range of agency types in the network. Given the structure of IMTs, with assigned roles for liaising with local agencies and disseminating public information, as well as the holding of regular meetings with cooperating agencies as part of operations, this coordinating role is not entirely surprising. Currently, there are no established standards for appropriate levels of bridging, nor is all-purpose proscription likely possible or even necessarily desirable. Yet, this finding presents an interesting metric for comparison in future studies of bridging versus direct ties to IMTs (or equivalent emergency coordination units) in wildfire response networks.

Turning now to nomination patterns exhibited by different types of nominating agencies, there was a notable tendency for respondents to nominate agencies of the same type as their own. Homophilic preferences could prove problematic of course for the same reasons as discussed in the opening pages of this paper—complex networks, especially in emergency response, where time is critical, can be overburdened by demands from multiple subgroups that do not exhibit similar preferences. Trust beyond one's immediate cohort potentially could facilitate more effective bridging in complex incident networks. However, there was a precipitous decrease in homophilic nominations in actual incident networks, suggesting that in many ways local responders reframed their homophilic preferences during the incidents. In addition, this highlights that an important way in which IMTs manage incident coordination and local relational dynamics is through liaising directly with many organisations in the network. This suggests ultimately, too, that the dissimilarity thesis might hold some weight over the similarity thesis in actual practice.

It is somewhat surprising, though, that county OEMs did not rank higher in pre- and post-fire IMT liaison nominations. One would expect them to do so because their institutional roles are principally to facilitate coordination between agencies and they have less direct operational responsibilities, such as firefighting. This is especially so in incident-based nominations, where they ranked even lower than they did in pre-fire nominations as IMT bridges, suggesting that, like fire service leaders, they played a less central role in response network bridging than the local community

expected. One possible explanation for this may be related to the order in which agencies are mobilised in response. Since wildfires frequently emerge from the forest, the USFS naturally engages first, frequently followed by law enforcement and the fire service, which must respond to road closures and structural protection imperatives in the earliest stages of wildfire spread to the WUI. Similarly, the issue might be jurisdictional, as landownership (such as county, federal, private, or state) often may dictate who is mobilised in leadership capacities. This may take precedence over the land's broader association with an adjoining county, especially in the early phases of an event. These other agencies are more likely therefore to be placed centrally in the network before county OEMs are engaged in response. Interestingly, while county OEMs are not particularly central as bridges to IMTs, they were the most central agency type nominated as a network leader during wildfire incidents, although federal land agencies received nominations from a greater range of agency types. This indicates that their roles were not entirely diminished in responder network coordination.

One way to interpret the discrepancy in pre- and post-fire nominations is that, when considering hypothetical wildfire emergency scenarios, respondents might be expected to think first of fire service agencies as natural leaders in these contexts. It is also worth noting that the rural regions of the American Northwest in the sample are known to exhibit a degree of mistrust in the federal government and tensions with federal land agencies are common (Anderson, 2006; Carroll et al., 2004, 2006; Fleming, McCartha, and Steelman, 2015), which could explain why these agencies are less likely to be nominated in hypothetical scenarios. Yet, it is important to consider whether this finding indicates that there are potential missed opportunities in network organisation in wildfire response in the region. Specifically, one is left to consider why fire services and other local agencies that a majority of respondents expect to play bridging roles in wildfire response frequently are less central, while federal land agencies instead take the lead.

Conclusion

This study has identified important patterns of preference and practice for bridging organisations in complex interagency networks in wildfire response in the American Northwest. In large-scale disasters, such as a wildfire, local and extra-local actors must come together to respond effectively to the threat, creating conditions where bridging actors play an essential part in the response. The research yielded much needed empirical evidence on the role of bridging actors in these disaster response networks. The generation of knowledge on bridging roles in disaster networks remains critical because coordination of action and the flow of information is essential to successful incident response and the prevention of conflict and cascading effects throughout the network.

The findings can be divided into two primary areas: theoretical; and practical. Theoretically, the study examines relationships between the theses of similarity and

dissimilarity in novel contexts of pre- and post–incident response networks. We find that idealised cognitive models do not correspond to practice; while there is a clear preference for similarity in pre-incident networks, this does not say much about how incident-based networks actually form. Similarity is a key element of how people envisage such a process, but, contrary to study expectations, there is a low correspondence between expectations and practice.

By understanding who people anticipate seeking and then identifying who is actually sought out, one can plan more realistically for effective disaster response. Practically, the findings suggest that:

- there are agency types that are preferred as bridges, yet they are not mobilised as such (fire service and, to a lesser extent, county OEM); and
- there is a possibility that agencies well-suited to play bridging roles (county OEMs) are less likely to fill these roles in practice.

Awareness of these patterns can be useful to agencies involved in wildfire response in a number of ways. First, they provide an opportunity—outside of immediate emergency settings—for agencies involved in wildfire response to evaluate and consider the preferences and practices of other organisations in incident-response networks. Second, they point to the need for wildfire-prone communities to build greater networks of trust and interaction outside of the fire season to extend trust in agencies other than their own. For instance, table-top exercises and response drills go a long way in building local relationships as people tend to trust familiar individuals over those they have not encountered previously. This is important in wildfire contexts as involved individuals are more likely to reach out to persons with whom they have an existing relationship. Ultimately, exercises that build larger and more diverse networks can help to fill gaps in the network during a time of crisis, creating increased potential for individuals in local agencies to serve as bridging actors with federal agencies involved in the same incident. Such activities could prove instrumental in forging greater consensus on which actors and agencies could be most effective in playing network leadership roles during an emergency. Finally, they present an opportunity to interrogate the competing operational and leadership priorities of the different agencies in a given network. In an emergency, operational priorities cannot be allowed to suffer due to network leadership demands; network leadership capacities can be augmented so as to minimise such risks. In the end, incident response is a social environment laden with culturally influenced perceptions and practices.

The findings highlight a need to bridge several social, cultural and, ultimately, operational gaps in wildfire response networks at the urban interface. Further research could help to refine understanding of these lacunae and address some of the limitations of this study. One limitation is that there was not a high degree of correspondence in the pre- and post-fire sample, meaning that it is difficult to examine change in specific respondents' nominations pre- and post-fire; however, attrition and varying response rates are common issues faced by all large survey studies, so it will be difficult to improve on this significantly in research of similar scope. Furthermore,

the samples over-represented fire service and municipal government in the pre-fire sample and county OEM, county government, fire service, law enforcement, and the state government in the post-fire sample. While this undoubtedly influenced the distribution and centrality of certain types of nominees, we are confident in the general patterns reported here, as we did not attempt to identify bridging nomination patterns by agency type. Nonetheless, future studies might develop recruitment strategies that represent better the diversity of agencies in wildfire response networks. Another course of further study could be to focus on a smaller set of incidents, although there would likely be pronounced challenges in anticipating sites of WUI wildfires using smaller regional sampling frames for pre-fire surveys. Finally, other studies could attempt to follow up with respondents on specific wildfire incidents to probe local interpretations for differences or correspondence concerning bridging actor preference and practice.

Ultimately, given the potential relational risks inherent in large wildfire response networks, research on the relational factors that influence performance and inclusion stands to make noteworthy contributions to theory and practice. While there are numerous relational and other contextual factors that are unique to large wildfire response, building a greater corpus of empirical and theoretical knowledge on wildfire response networks has the potential to contribute to theory and practice in a variety of risk, hazard, and disaster contexts. Disaster risk reduction, hazard mitigation, emergency response, and disaster recovery all entail the mobilisation of multiple organisations, communities, and individuals, and increased awareness of the factors that influence effective network mobilisation and the meaningful inclusion of all stakeholders is fundamental to success in these areas.

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2 See http://firechasers.ncsu.edu (last accessed on 24 June 2016).

3 Operationalised as a Type I or Type II fire event involving evacuations, road closures, and/or threatened structures.

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