



Polycentric systems for wildfire governance in the Western United States

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ABSTRACT

In order to increase the pace and scale of managing forests to reduce wildfire risk in the western U.S., federal agencies have adopted policies that promote an all lands management (ALM) approach, which extends management actions across jurisdictional boundaries. To better implement such policies, ALM approaches require new governance systems that overcome barriers found in existing systems, which typically address jurisdictions separately. Polycentric governance systems, characterized by multiple and diverse actors at different scales operating in coordination with one another under an overarching set of rules, have emerged to address wildfire risk in multi-ownership landscapes. We describe these polycentric systems using three case studies of US Forest Service-Natural Resources Conservation Service Joint Chiefs' Landscape Restoration Partnership projects in Oregon and California. While all three cases demonstrate polycentric systems, we found diversity in terms of partnering organizations and levels of success in implementing wildfire risk reduction projects. Lessons from our research can inform more effective implementation of ALM policies for managing natural resources and processes in multi-jurisdictional landscapes. Our research suggests these systems can be strengthened when: bottom-up and top-down processes and incentives for establishing them converge; actors within the system coordinate effectively; policies enable flexibility and adaptiveness for how systems function in different places; multiple actors at multiple scales are able to supplement one another's capacity; and legal and policy mechanisms facilitate efficient transfer of funding and resources between actors in the system to accomplish work.

1. Introduction

Fire has shaped landscapes of the western United States for millennia, but its exclusion since Euro-American settlement has created unanticipated consequences. These include degraded ecosystem health as a result of overcrowding of vegetation, loss of fire-resilient forest structure and composition, loss of biodiversity and rare habitats, and risk from increasing frequency of large, high-severity wildfires that escape suppression (Hessburg et al., 2015; Ryan et al., 2013). Prominent scientists have argued for scaling up restoration treatments, which vary geographically according to social and ecological objectives, but which generally include forest thinning, prescribed fire, or managed wildfire in order to address ecological problems resulting from fire suppression (Churchill et al., 2013; Lindenmayer and Franklin, 2002; North et al., 2015). These calls for restoration are particularly pressing because of the rising costs of suppressing wildfires, losses of life and property associated with those fires, and the loss of benefits from more frequent historical fires that promoted landscape

heterogeneity and contributed to biodiversity (Daniel et al., 2007; Prestemon et al., 2008; Gebert and Black, 2012). In response to these threats from changed wildfire patterns, policy makers, landowners and land managers, non-governmental organizations (NGOs) and others have called for large-scale, cross-ownership boundary fire and fuels management projects that proactively address wildfire risk and re-incorporate fire as a beneficial ecological process on the landscape (Bixler et al., 2016; USDA Forest Service, 2018). Doing so makes sense because the scales at which ecological processes operate do not correspond to established social and political boundaries.

This shift in forest management in response to changing ecological conditions is referred to by several land management agencies in the U.S. as the "all-lands approach," or "all-lands management" (ALM), the term we use here. A number of national policy documents promote this approach, for example the U.S. Forest Service (USFS) 2012 Planning Rule, the National Cohesive Wildland Fire Management Strategy, the National Association of State Foresters All Lands Policy Platform (Charnley et al.,

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2017) and the Department of Interior's 2017 Wildland Fire Directive (DOI, 2017). However, different landowners and landowner types have differing capacities, legal and policy frameworks, and objectives pertaining to the use and management of their lands (Scarlett and McKinney, 2016). Thus, scaling up is not simply an additive process of bringing more people to the table, but requires changed governance that reflects the multiple scales and authorities involved in decision-making.

We observe that ALM has been accompanied by an emerging form of landscape governance that resembles a polycentric system, in which “multiple public and private organizations at multiple scales jointly affect collective benefits and costs” (Ostrom, 2012, p. 355). We therefore look to the literature on polycentric systems (or polycentric governance systems) to frame the transition to ALM in fire-prone landscapes in the western U.S. We conceive of polycentric wildfire governance as a governance system in which authorities at nested scales make and implement policies and rules related to shared wildfire risk across multi-jurisdictional landscapes, with multiple centers of power that overlap (Chaffin et al., 2014; Huitema et al., 2009), creating “inter-related decisional contexts” (McGinnis, 2011, p. 52). Within polycentric systems, redundancy of authority helps to maintain adaptiveness in case of disturbance and surprise (Huitema et al., 2009; Armitage et al., 2007).

Polycentric systems partly address resource management problems arising from the stark jurisdictional lines found in the western U.S. On fire-prone landscapes in the U.S., federal and state governments throughout most of the 20th century assumed responsibility for wildfire management on their respective jurisdictions (public and private lands), but also engaged in cooperative wildfire management across jurisdictions (Steen-Adams et al., 2017). By defining the relationship between people and space, a jurisdiction forms a “claim to governance” over space and delineates who exercises power where (Pasternak, 2014). As Valverde (2009) explains, jurisdictions separate authorities, keeping “incommensurable processes, or processes with incommensurable logics... from clashing by being assigned to different authorities” (p. 145). But in a multi-jurisdictional landscape with federal, state, tribal, and private property ownerships, wildfire risk reduction is a public good, and as such, it embodies a collective action problem as described by Cole (2008), in which solutions require cooperation among multiple actors who may have differing interests and incentives. Polycentric wildfire governance systems attempt to address this quandary, with actors able to exercise power across jurisdictional boundaries through particular authorities and relationships related to wildfire risk reduction, though landowners and managers retain ultimate decision-making authority on their individual ownerships.

We argue that polycentric wildfire governance systems are better suited to implementing ALM than current systems that are either hierarchical or decentralized, because polycentric systems allow landowners and managers to plan and implement wildfire treatments across historically disparate jurisdictional boundaries and authorities, especially across public and private land ownerships. The purpose of this paper is to help facilitate effective implementation of ALM policies through polycentric wildfire governance by (1) characterizing emergent polycentric systems for achieving ALM and how they are operating on the ground; and (2) distilling lessons learned from this emergence. We draw on case studies of three ALM projects that received funding through the USFS-Natural Resources Conservation Service (NRCS) Joint Chiefs' Landscape Restoration Partnership (Joint Chiefs) to illustrate this shift towards polycentric wildfire governance. The Joint Chiefs program was initiated in 2014 to fund restoration projects for three-year periods that aim to improve forest health and resiliency in landscapes with both public and private lands. It is one of the prominent federal mechanisms currently in place for bringing multiple landowners together to adopt an ALM approach to wildfire risk management (Cyphers and Schultz, 2019).

1.1. Shifting landscape governance in response to wildfire risk in the western U.S.

1.1.1. From bureaucratic hierarchies to collaborative groups

Wildfire governance on landscapes across the western U.S. has been traditionally vested in bureaucratic hierarchies, such as the USFS on national forest lands (per MacCleery, 2008; Pahl-Wostl, 2009), which are dominated by government actors in an expert-driven model (Hayes, 1959; Abrams et al., 2017; Scarlett and McKinney, 2016). The shift in forest management on federal lands from sustained-yield timber harvesting to ecosystem management in the early 1990s brought with it a new approach to forest governance on federal lands (Cortner and Moote, 1999). Though geographically uneven, federal forest management in many areas has become more decentralized, shifting toward community-based forest collaborative groups (“forest collaboratives”). These groups include diverse stakeholders seeking common ground through collaborative decision-making in order to provide input to federal land managers, and engage in joint planning for prioritizing and implementing forest management and economic development (Cheng and Sturtevant, 2012; Davis et al., 2017; Wondollock and Yaffee, 2000). Forest collaboratives have created strategic partnerships to overcome distrust between opposing or adversarial groups, including both timber industry and conservationists, building agreement and capacity for accomplishing ecological and economic goals through federal land management (Abrams et al., 2015; Davis et al., 2017). This approach was codified in the USFS 2012 Planning Rule, which prioritized a “transparent, collaborative process” in creating (USFS) forest management plans, and recognized that a “one-size-fits-all” approach could not meet the needs of diverse ecological and social systems (USDA, 2012).

Most forest collaboratives have been initiated by governmental agencies that reach out to non-governmental actors in order to engage in collaborative decision-making and conflict resolution about proposed projects on federal lands (Ansell and Gash, 2008; Butler and Schultz, 2019). Lessons from collaborative federal lands projects include the need for effective leadership, inclusion of a range of participants representing all interests, joint fact-finding and monitoring, transparency, adherence to clear ground rules, shared ownership of the process, and identification of common problems and values (Ansell and Gash, 2008; Butler and Schultz, 2019; Fernandez-Gimenez et al., 2004; Wondollock and Yaffee, 2000). These collaborative processes also require sufficient financial, human, social, and political capital, and the ability to use these capitals to organize, implement, and evaluate projects (Cheng and Sturtevant, 2012). Collaborative forest management has been accompanied by a “network governance” model in which the USFS has become increasingly reliant on formal and informal partnerships with outside entities that lend it capacity and legitimacy to accomplish forest management work (Abrams et al., 2017).

While Kittredge (2005) found that few forest collaboratives develop in the absence of federal agencies and their programs, agency participation brings bureaucratic challenges, including long planning timelines, inflexibility, a culture focused on risk aversion rather than project priorities, and the difficulty of engaging in meaningful collaboration when federal agencies retain statutory decision-making authority (Butler, 2013; Cortner and Moote, 1999). Additionally, the “large, slow-moving variables” of the federal agency bureaucracy hinder innovation at local levels (Abrams et al., 2017). Agencies such as the USFS may defend their hierarchical structure, with agency leaders at times contradicting, overturning, or de-emphasizing the priorities of locally-based collaborative groups (Yaffee and Wondollock, 2003). Moreover, locally-based collaborative groups do not necessarily have strong representation by local landowners whose lands border, or are intermixed with, federal lands.

A central tenet of ecosystem management was that ecosystems should be managed at the watershed and landscape levels, across jurisdictions, to sustain healthy ecosystem processes and functions and conserve biodiversity (Brunson et al., 1996; Cortner and Moote, 1999).

Table 1
 Joint Chiefs projects in our sample. Source for Joint Chiefs funding: [NRCS, 2019](#); these are budgeted numbers, final distributed funding was higher for all three cases.

Project	State	Years funded	Total funding (budgeted)	Distribution of funding USFS/ NRCS	Size of project planning area (ha)	Land ownerships > 2.02 ha
Ashland Forest All-Lands Restoration ("Ashland")	Oregon	2015–2017	\$6,169,410	35%/65%	21,000	USFS, BLM, City of Ashland, private corporate (n = 1), family (n = ~458 total; projects on 53)
East Face of Elkhorn Mountains ("East Face")	Oregon	2014–2016	\$4,939,000	43%/57%	52,000	USFS, BLM, OR Dept. of Fish & Wildlife, private corporate (n = 1), family (n = ~262 total; projects on 61)
Middle Klamath River Communities ("Klamath")	California	2014–2016	\$4,787,615	70%/30%	~4000+	USFS, family (n = ~38 total; projects on 18)

However, in the U.S., forest collaboratives have mostly focused solely on federal lands. This is despite research suggesting a willingness among family forest owners to participate in ecosystem and wildfire management across jurisdictions ([Brunson et al., 1996](#); [Creighton et al., 2002](#); [Fischer and Charnley, 2012](#)). In part, forest collaboratives have focused on federal lands because policies governing their management allow for public input into decision-making ([Cervený et al., 2018](#), and citations therein), in contrast to policies on private lands.

The tendency for forest collaboratives in the western U.S. to focus on a single ownership type (federal lands) means that they have not developed governance structures to work across ownership boundaries to incorporate private, state, and tribal lands in project planning and implementation. Additionally, while state and federal agencies have coordinated in wildfire suppression, including resource sharing and joint decision-making responsibility (*i.e.*, "overlapping authority"), this has not extended much beyond suppression ([Davis, 2001](#); [Fleming et al., 2015](#)). There have been some precedents for cross-ownership boundary forest management projects (*e.g.*, the Applegate Project described in [Wondolleck and Yaffee, 2000](#); [Charnley et al., 2017](#); [Fischer et al., 2019](#) for examples of coordinated forest management among private forest owners), but it has only been in the last decade with the policy shift toward ALM that there has been a concerted effort at the state and federal levels to implement cross-boundary projects. Thus, although ALM builds upon years of lessons from collaborative work on federal lands, it also brings new challenges and opportunities as stakeholders attempt to cross jurisdictional boundaries in planning and implementing wildfire risk reduction treatments at a landscape scale.

1.1.2. Polycentric governance systems

Polycentric systems are self-organized systems characterized by (a) multiple and diverse actors at different scales that each have some degree of autonomy and authority to formulate and implement rules or policies within a specified domain or geography; (b) the existence of overlapping centers of power that extend across jurisdictions, creating some redundancy; (c) interaction among actors (*e.g.*, communication, resource sharing, coordination, cooperation); (d) an overarching set of rules within which they operate; and (e) the ability of actors to influence each other's decisions and jointly affect collective costs and benefits ([Andersson and Ostrom, 2008](#); [Chaffin et al., 2014](#); [Huitema et al., 2009](#); [Nagendra and Ostrom, 2012](#); [Ostrom, 2010, 2012](#); [Pahl-Wostl, 2009](#); [Pahl Wostl and Knieper, 2014](#); [Schröder, 2018](#)).

Polycentric systems may enable better management outcomes by distributing responsibilities and capabilities among different actors at different levels; offsetting limitations to, and lack of sufficient incentives for, management within the system; increasing institutional capacity and resources for addressing natural resource problems; and providing opportunities for innovation and adaptation ([Andersson and Ostrom, 2008](#); [Pahl-Wostl, 2009](#)). By operating at different scales, they may also provide the benefits of decentralized, community-based management "while addressing causes and consequences of social and ecological issues crossing spatial and jurisdictional scales" ([Wyborn and Bixler, 2013](#), p. 59). They also allow for management to occur at different scales simultaneously ([Scarlett and McKinney, 2016](#)). Polycentric systems may lead to more adaptive management because the plurality of viewpoints and redundancy of functions inherent within polycentric approaches help the system remain resilient in the face of change ([Andersson and Ostrom, 2008](#)). In the context of ALM, flexibility and multi-tiered institutional support and decision-making are necessary because of the complexity of planning and implementing projects that cross diverse land ownerships. Polycentric systems can provide this flexibility and support.

Polycentric governance is presented as a normative ideal for resolving complex problems ([Bixler, 2014](#); [Ostrom, 1998](#)), but its implementation presents challenges. The difficulties of coordination across organizations with differing capacities and objectives, and regulatory redundancy, create inefficiency and high transaction costs

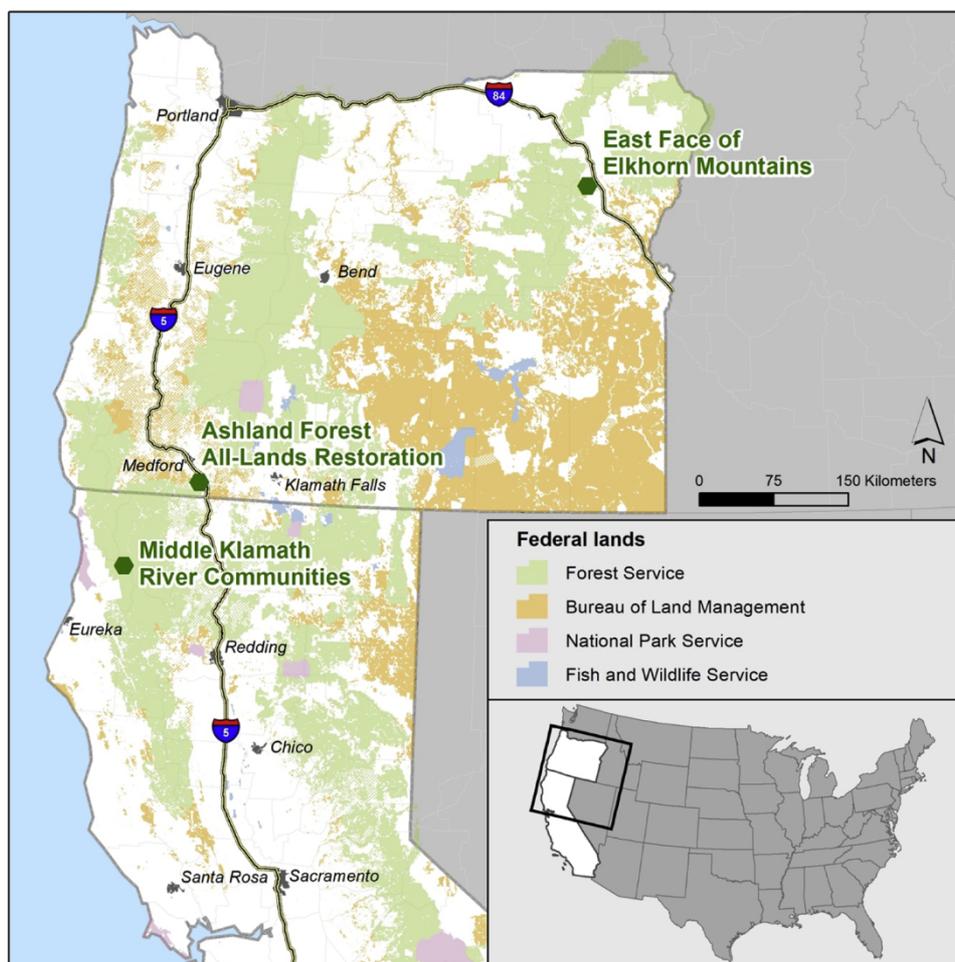


Fig. 1. Locations of the three Joint Chiefs projects in our sample.

(Mewhirter et al., 2018; Pahl-Wostl, 2009; Sovacool, 2011). Thus, polycentric systems are not always the best forms of natural resource governance, depending on local context (Heikkila et al., 2018). There is a need to learn from others’ experiences with polycentric systems and to articulate the lessons learned when new polycentric systems are attempted so as to improve their performance.

2. Methods

We chose three case study projects that are part of the Joint Chiefs program (Table 1). The projects in our sample are located in Oregon and California (Fig. 1) and include diverse landowner types: private corporate, family forest, federal, state, and municipal. We used Joint Chiefs projects for our sample frame because these projects exemplify the ALM approach to forest restoration by funding work on both public and private lands across large landscapes; in the western U.S., reducing wildfire risk is often a key goal; and projects occur across geographic regions of the U.S., allowing for comparison in different contexts. The three projects we chose were funded early in the Joint Chiefs program, allowing us to derive lessons learned throughout the three-year course of each project.

At each case study site, we conducted semi-structured interviews with a purposive sample of project participants (Ashland = 17; East Face = 11; Klamath = 25). Interviewees were purposively selected because of their inclusion in the projects, either as key personnel from participating organizations, participating stakeholders, or landowners whose lands were included in the project area (whether or not they actually participated in the project). We created an interview guide for

consistency across the cases. Though semi-structured, interview length and topics covered varied according to the expertise and interest of the interviewees. Interviews were recorded and transcribed, then coded for themes. We asked interviewees about their experiences with ALM, other actors in the ALM network and their roles, accomplishments under ALM, and enabling factors and constraints for implementing fuels reduction projects under ALM.

For family forest owners, we also implemented a survey across all three sites following the Dillman method (Dillman, 2000). Among other questions, the survey asked about landowner characteristics and awareness of (and experience with) ALM projects and the agencies involved in the Joint Chiefs program. We mailed a total of 1026 surveys to all family forest owners within the three project sites who owned more than 2.02 ha of land (Table 2). We identified individual landowners using GIS project boundary layers combined with tax lot data. Though not the focus of this manuscript, we include some lessons learned from the survey.

Table 2
Family Forest Owner Survey sample (response rate is for landowners with > 2.02 ha of land).

Case Study Project (# surveys mailed)	Number of Survey Responses response rate)
Ashland Forest All-Lands Restoration (458)	139 (30.3%)
East Face of the Elkhorn Mountains (262)	74 (28.2%)
Middle Klamath River Communities (306 – included full Western Klamath Restoration Partnership area)	72 (23.5%)
Total surveys mailed: 1026	285 (26.8%)

We also reviewed documents about the projects from agencies, NGOs, and the popular media in order to obtain more information about the projects. We participated in events coordinated by the Joint Chiefs projects, including workshops, field tours, and collaborative group meetings in order to engage in informal conversations, learn about project implementation, and see the impacts of management on the ground.

3. Results: case studies of polycentric wildfire governance systems

Each of the Joint Chiefs projects in our study evolved from pre-existing collaborative relationships among some of its partners. We briefly describe this evolution, then characterize the polycentric governance system associated with each project, identifying the actors and their roles. We also discuss attributes of the polycentric governance system in each case that both enabled and constrained implementation of treatments for wildfire risk reduction to identify lessons learned. We focus on the relationships among actors and organizations in our ALM projects to understand how these relationships influenced project outcomes. Specifically, we address how projects built on previously-developed partnerships; how partners worked to supplement one another's capacity to plan and implement fuels treatments; and how actors in the system coordinated with one another.

3.1. Ashland forest all-lands restoration project

The Ashland project in southwestern Oregon received Joint Chiefs funding in 2015. The project developed from a legacy of partnerships that started in 1929 with a cooperative agreement between the City of Ashland and the USFS to jointly manage the Ashland Creek Municipal Watershed, the city's water supply. In 1999, multiple local stakeholders created a community alternative to a proposed USFS forest management project in an attempt to change management from commercial timber production to restoration- and resilience-based management. This project evolved over time in response to a Community Wildfire Protection Plan created in 2004, and establishment of the ten-year Ashland Forest Resiliency (AFR) Stewardship Project in 2010. The AFR Stewardship Project is a partnership between the city of Ashland, an NGO called the Lomakatsi Restoration Project, The Nature Conservancy (TNC), and the USFS to carry out hazardous fuels reduction. A USFS Master Stewardship Agreement formalized the partnership in 2010 between federal and non-federal partners to jointly plan and conduct restoration work on the Rogue River-Siskiyou National Forest (RRSNF).

The Ashland Joint Chiefs project was essentially an expansion of the AFR project (whose initial funding expired in 2013) that added partners, including NRCS, and expanded the project area from 8900 to 21,000 ha by including private and municipal lands surrounding the original boundary. Its goals were to reduce and mitigate wildfire threats to communities and landowners, protect water quality and supply in the Ashland Municipal Watershed, and improve and protect quality wildlife habitat for threatened, endangered, and at-risk species. To achieve these goals, the Ashland project planned to implement treatments across the RRSNF and family forest lands to significantly reduce the risk of extreme wildfire events.

Table 3 describes the roles that each actor in the governance system played in the project. The polycentric governance system that formed to facilitate project implementation is displayed in Fig. 2. There were approximately 2900 ha treated under the Joint Chiefs project, with 1600 ha on RRSNF and 1300 ha on private lands. Funding from the Joint Chiefs project was supplemented with funding from the state (Oregon Watershed Enhancement Board) and the city of Ashland.

3.1.1. Enabling factors

The Ashland project was largely considered a success, and the partners have continued to implement fuels treatments across the project area since the Joint Chiefs funding ended with money from

other sources, in particular a new Oregon Watershed Enhancement Board grant. The Ashland project provided funding and reinforced partnerships to scale up fuels reduction work begun in 2010, and incorporated family forest owners nearby public (mostly national forest) lands. Factors contributing to project success were:

- Building on previously-developed partnerships

The AFR Stewardship Project initially received approximately \$6 million in American Recovery and Reinvestment Act funds for fuels reduction work on national forest lands in 2010, which jumpstarted forest restoration work in the region. Development of a Master Stewardship Agreement between the RRSNF and non-federal partners provided a mechanism for moving money and resources among partners. This agreement increased flexibility in decision-making, built capacity to accomplish fuels reduction work, enabled partners to play different roles in supporting it as needed, and facilitated collaborative planning of fuels treatments that took the interests of all partners into account. One NGO representative described the agreement as being key to obtaining Joint Chiefs Funding in 2015 because of the foundational partnership that already existed. The RRSNF used Joint Chiefs money to continue fuels reduction work with pre-existing partners under the Master Stewardship Agreement, and NRCS joined the partnership to plan and fund treatments in priority areas on private lands with Joint Chiefs money.

- Supplementing partners' capacity to implement treatments

Joint Chiefs funding provided resources to continue fuels reduction work on the RRSNF. But as interviewees explained, the USFS did not have sufficient staff capacity to scale up and treat the desired number of hectares. Therefore, multiple partners leveraged both funding and workforce capacity to accomplish treatments on USFS land, including funds from the Oregon Watershed Enhancement Board, and a City of Ashland surcharge on household water bills earmarked for forestry projects to protect the municipal watershed (almost entirely USFS land).

One important partner in capacity-building was Lomakatsi, which developed a workforce that began doing restoration work on private lands and extended that work to public lands. Under the Master Stewardship Agreement, Lomakatsi (or its sub-contractors) laid out and implemented fuels treatments on federal lands. It also worked in partnership with NRCS to accomplish treatments on family forest ownerships. Although NRCS has planners on its staff, it did not have the capacity to undertake all of the planning required to accomplish private lands treatments under the Joint Chiefs project. Lomakatsi, with leveraged funding from outside sources, played the lead role in working with private landowners who received NRCS cost-share funding to conduct inventories on their property and plan fuels treatments. Most landowners then hired Lomakatsi to perform those treatments.

Lomakatsi worked across land ownerships with the support of the community despite some community members' distrust of both logging and agency decision-making. This was due in part to Lomakatsi's careful attention to implementing what one interviewee described as an "ecological fuels reduction approach." Timber operators in southern Oregon were trained in the ecological fuels reduction approach and incorporated it into these projects. This allowed the local workforce, once focused on traditional timber operations, to re-orient toward management that achieved the goals of wildfire risk reduction and watershed health. Implementing socially-acceptable fuels treatments helped to build the community trust and social license necessary to accomplish work across land ownerships.

Another critical partner was the City of Ashland. The City's Municipal Fire Department took the lead on conducting outreach to private landowners about the importance of treating fuels on their properties because NRCS felt they would be more successful in recruiting project participants given their high level of trust with the community. The City also took the lead on communication, education,

Table 3
Key Actors in the Ashland Forest All-Lands project and their roles.

Actor	Type	Role
<i>National</i>		
Forest Service	Federal agency	Implemented fuels reduction treatments on about 1600 ha of the RRSNF in collaboration with AFR partners; coordinated with NRCS and partners to plan and implement the Joint Chiefs project; provided funding to AFR partners for project monitoring, and communication and outreach to the public and family forest owners
NRCS	Federal agency	Provided cost-share funding to family forest owners for fuels treatments; coordinated with USFS, city, and Lomakatsi to plan communication and outreach to landowners and treatment locations across ownerships; coordinated with Lomakatsi, which planned and conducted treatments on family forest lands
U.S. Fish and Wildlife Service	Federal agency	Conducted technical review to ensure compliance with federal policy requirements; contributed funding to help implement projects on private lands through Partners with Fish and Wildlife program
The Nature Conservancy	National NGO	Led Multi-Party Monitoring Program and technical review; facilitated dialogue among the leadership of USFS, NRCS, Oregon Dept. of Forestry; conducted outreach and education to community residents
<i>State</i>		
Oregon Dept. of Forestry (ODF)	State agency	Worked with partners to conduct outreach to and support family forest owners; supported activities to promote wildfire protection in local communities, including education
Oregon Watershed Enhancement Board	State agency	Provided grant funding to support habitat improvements for native fish and wildlife on public and private ownerships
<i>Regional</i>		
Lomakatsi	Regional NGO	Conducted outreach to family forest owners; planned and implemented treatments across ownerships
<i>Local</i>		
Jackson Soil and Water Conservation District	County agency	Provided personnel to assist NRCS and Lomakatsi with creation of family forest owner management plans, which are required to qualify for NRCS funding
Family forest owners	Local landowners	Received financial and technical assistance from NRCS and Lomakatsi to plan and implement treatments on their properties (~1300 ha)
City of Ashland	Municipal government	Conducted treatments on city lands (~22 ha); helped plan and implement treatments across land ownerships; conducted outreach and education to private landowners and community members; provided funding through a water bill surcharge for implementing restoration projects on federal lands in the municipal watershed

and outreach about project activities on USFS lands. In addition, the city has a dedicated forester who provided technical assistance to the RRSNF by helping write the prescriptions for fuels treatments, supplementing RRSNF staff capacity to plan treatments.

- Coordination among actors

TNC played a key role in linking federal and non-federal (community) members by guiding and facilitating the collaborative restoration process. TNC also played an important role in conducting outreach and education to the community about the importance of fuels reduction, building community support for it, and articulating the problems and possible solutions associated with hazardous fuels treatments. TNC also

developed and implemented a multi-party monitoring program that enlisted area professionals from outside the partnership to monitor and evaluate restoration outcomes on federal lands using science-based methods, in support of adaptive management. The city, through its communication and outreach activities (described above), was also key in linking actors and organizations.

3.1.2. Constraints

The constraints of the polycentric system established under the Ashland project were largely described in terms of limited USFS capacity and/or bureaucratic complexity, which according to several interviewees, led to a loss of trust as they saw planned fuels projects unfulfilled or delayed. This was at times exacerbated by employee

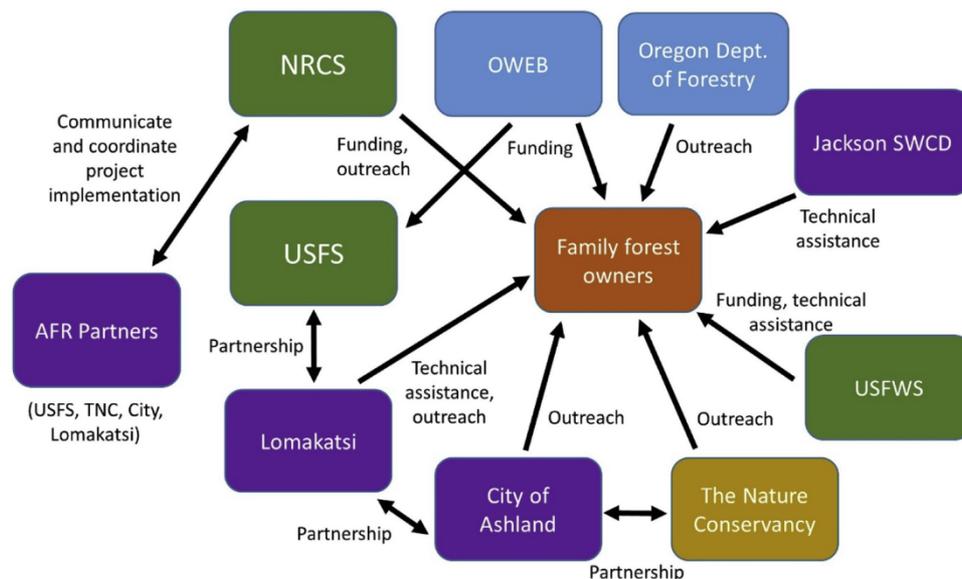


Fig. 2. Polycentric governance network of federal (green), state (blue), national NGO (mustard), regional/local (purple), and family forest owner (orange) actors in the Ashland Forest All-Lands Restoration project.

turnover, described as leading to a loss of institutional memory and the need to get new employees “up to speed really quick.”

3.2. East Face of Elkhorn Mountains Project

The East Face project, located in the Blue Mountains of eastern Oregon, was one of the first projects to receive funding through the Joint Chiefs program in 2014. The project evolved from the Northern Blue Mountain Cohesive Strategy Pilot Project, initiated in 2013 as one of three pilot projects in the western U.S. for the National Cohesive Wildland Fire Management Strategy. The Cohesive Strategy pilot projects were developed as a national model for engaging local stakeholders in managing forests and wildfire. The Northern Blue Mountains pilot project covered roughly 3 million ha of northeastern Oregon and southwestern Washington and included multiple land ownerships (Blue Mountains Cohesive Strategy n.d.). Many federal and state agencies, local leaders, landowners, Tribes, and other stakeholders worked together to develop an action plan for implementing the project. About this time, the Joint Chiefs program was announced. Group members decided to develop and request funding for the East Face project as part of the Blue Mountains pilot project, and were successful. The Wallowa Whitman Forest Collaborative, formed in 2012 to address management and restoration of the Wallowa Whitman National Forest (WWNF, the USFS lands of focus in the East Face project), played an important role in facilitating this process. Many key players in the polycentric governance system associated with the East Face project were also members of this collaborative group, which provided a forum for relationship building and coordinating restoration activities on different ownerships across the project area.

The East Face project goals were to (a) reduce the potential for high-severity wildfire and associated damage by increasing fuels treatments on public and private lands; (b) protect people and structures from wildfire in the wildland-urban interface; (c) reduce the likelihood of wildfire transmission from federal to state and private lands by focusing treatments along shared borders; and (d) increase economic opportunities associated with forest restoration in local communities. Some of the East Face project partners had a history of working together to achieve shared goals that pre-dated the Cohesive Strategy Pilot Project, such as the NRCS and Oregon Department of Forestry (ODF); others did not, such as the USFS and NRCS.

The East Face project supported fuels reduction treatments on federal (WWNF, Vale Bureau of Land Management [BLM] District), state (Elkhorn Wildlife Management Area), and family forest land ownerships within the project area. Table 4 describes the roles that each actor played in the project. The polycentric governance system that formed to facilitate project implementation is displayed in Fig. 3. Altogether, fuels treatments were planned for implementation on 9000 ha of national forest land, over 80 ha of Oregon Department of Fish and Wildlife (ODFW) land, and 2200 ha of family forest land. Treatments were also planned on roughly 500 ha of BLM land. Implementation was at different stages on different ownerships when the project formally ended after three years, though work has continued.

3.2.1. Enabling factors

Although fuels treatments were still ongoing when the East Face project ended, it was largely considered a success. Joint Chiefs project funding provided an incentive for landowners and other stakeholders who share wildfire risk in the East Face project landscape to work together. Key to success were the strong relationships that existed between actors in the system, some of which pre-dated the project and were strengthened by it, and some of which were new.

- Building on pre-existing partnerships

The fact that many actors in the East Face project were already working together on the Cohesive Strategy Pilot Project made it easier

for them to respond to the call for project proposals when the Joint Chiefs program was announced, and to bring in new partners as appropriate. The Wallowa Whitman Collaborative, which formed around the same time, also provided a forum for interaction and coordination among landowners and other stakeholders who were interested in conducting forest restoration across land ownerships.

- Supplementing partners' capacity to conduct treatments

Numerous partnerships formed under the auspices of the East Face project that enabled different actors to obtain the capacity they needed, but did not have alone or internally, to conduct fuels reduction treatments. For example, NRCS had funding, but no foresters on staff to work with family forest owners. The ODF had foresters, but limited funds for working with landowners. Thus, NRCS gave Joint Chiefs money to ODF to pay their foresters to provide the forestry expertise needed to help landowners plan and carry out fuels treatments. NRCS also provided cost-share funds to landowners to hire contractors to conduct fuels treatments on their properties that may not have occurred without this incentive.

The USFS also leveraged resources to help implement fuels treatments across ownerships. The agency aimed to treat along shared boundaries with private and state landowners. The ODFW manages a state wildlife area that shares a boundary with the WWNF, and these lands were in need of treatment. However, ODFW had neither funding nor forestry expertise to do so. Although NRCS can provide funding to treat on private ownerships, it cannot fund treatments on state lands. Similarly, the USFS had no mechanism for moving Joint Chiefs money to ODFW. However, it did have a mechanism for moving Joint Chiefs funding to ODF, and ODF in turn transferred the funds to ODFW. This money was used to initiate commercial treatments on ODFW lands and pay for non-commercial treatments there. The ODF also provided a forester to plan the timber sales and fuels treatments. The ODFW has been able to reinvest the revenues generated by the timber sales in preparing and implementing commercial treatments on four other wildlife management areas in eastern Oregon to improve wildlife habitat and reduce fuel loads. Timber sale revenues were also used to hire a forester whose position is now shared between ODF and ODFW to support management of state lands in eastern Oregon in the future. These two state agencies had not previously worked together in eastern Oregon.

Similarly, the USFS provided capacity to the BLM to make it easier for this agency to conduct restoration treatments. The BLM manages land in need of fuels reduction within the project area, but their internal resources are focused on management of the greater sage grouse (*Centrocercus urophasianus*), a species at risk. Therefore, the USFS included BLM lands in the NEPA analysis it performed for fuels treatments on both federal ownerships, which it had the authority to do. This is enabling the BLM to implement fuels treatments in the project area as funds become available.

- Coordination among actors

Actors at the federal, state, and local levels conducted outreach to family forest owners to encourage them to manage their forestlands to reduce wildfire risk, and make them aware of resources available for doing so. Consequently, nearly two-thirds of all family forest owners within the East Face project area who responded to our survey were aware of the project (unpublished survey data). In addition, 26% of East Face landowners who responded to the survey participated in the project in some way, and 23% of the landowners in the project area applied for and received cost-share funding from NRCS. These participation numbers are much higher than those for the other two cases included in the survey, reflecting the effectiveness of this coordinated landowner outreach effort.

The Wallowa Whitman collaborative group worked closely with the

Table 4
Key Actors in the East Face of Elkhorn Mountains project and their roles.

Actor	Type	Role
<i>National</i>		
Forest Service	Federal agency	Planned fuels reduction treatments on ~ 9000 ha of the WWNF focused along shared boundaries with private and state landowners in collaboration with the Wallowa Whitman Collaborative, and began implementation; distributed Jt. Chiefs funding to ODF to support a variety of activities related to wildfire risk reduction across ownerships; coordinated with NRCS to plan and implement treatments on private lands; conducted NEPA ^a analysis for fuels treatments on BLM land; conducted outreach to family forest owners
NRCS	Federal agency	Provided cost-share funding to family forest owners for fuels treatments; coordinated with USFS to implement the project and plan treatments across ownerships; funded an ODF forester to provide technical assistance to family forest owners
BLM	Federal agency	Conducting fuels treatments on ~ 500 ha of BLM land inside the East Face Project area where the USFS completed NEPA analysis
American Forest Foundation	National NGO	Coordinated with ODF to pilot test a family forest owner outreach strategy and materials in the project area designed to connect landowners to information, services, and professionals to help them manage their forests and reduce wildfire risk
<i>State</i>		
Oregon Dept. of Forestry (ODF)	State agency	Used NRCS funds to provide forester to help plan, oversee, and certify fuels treatments on family forest lands; provided forester and USFS funding to ODFW to plan and pay for initial treatments; helped conduct outreach to family forest owners; supported activities to promote wildfire protection in local counties including education and outreach, biomass utilization planning, and community wildfire protection plan implementation
Oregon Dept. of Fish & Wildlife (ODFW)	State agency	Conducted timber sales and fuels treatments to improve wildlife habitat and reduce wildfire risk on over 80 ha of the Elkhorn Wildlife Management Area; used timber revenue to pay for additional treatments on the Elkhorn, hire a part-time forester, and kick-start treatments on other ODFW lands in northeastern OR
Oregon State University Extension	University extension office	Conducted outreach to family forest owners to provide information about resources available to help them manage their forests and reduce wildfire risk
<i>Local</i>		
Family forest owners	Local landowners	Applied for cost-share funding through NRCS to conduct fuels treatments on their properties (~ 2200 ha); if successful, worked with ODF forester to plan treatments and hired contractors to implement them (or did so themselves)
Wallowa Resources	Local NGO	Helped form and lead the Wallowa Whitman Collaborative; conducted outreach to family forest owners to encourage forest management and wildfire risk reduction; spearheaded a partnership to help private forest owners throughout the Blue Mountains obtain information and resources to reduce wildfire risk on their properties (My Blue Mountains Woodland)
Wallowa Whitman Collaborative	Local forest collaborative group	Collaborated with Wallowa Whitman National Forest staff in planning fuels treatments within the East Face project area on the national forest

^a NEPA = National Environmental Policy Act, a federal policy requiring agencies to analyze, disclose, and consider alternatives to federal actions that may have environmental effects.

national forest to plan the size, location, and types of fuels treatments to be conducted there. None of these fuels projects have been appealed or litigated, and they are moving forward as planned. As already noted, representatives of most agencies and organizations involved in the

broader East Face project participated in the Wallowa Whitman collaborative, which facilitated communication and coordination for ALM.

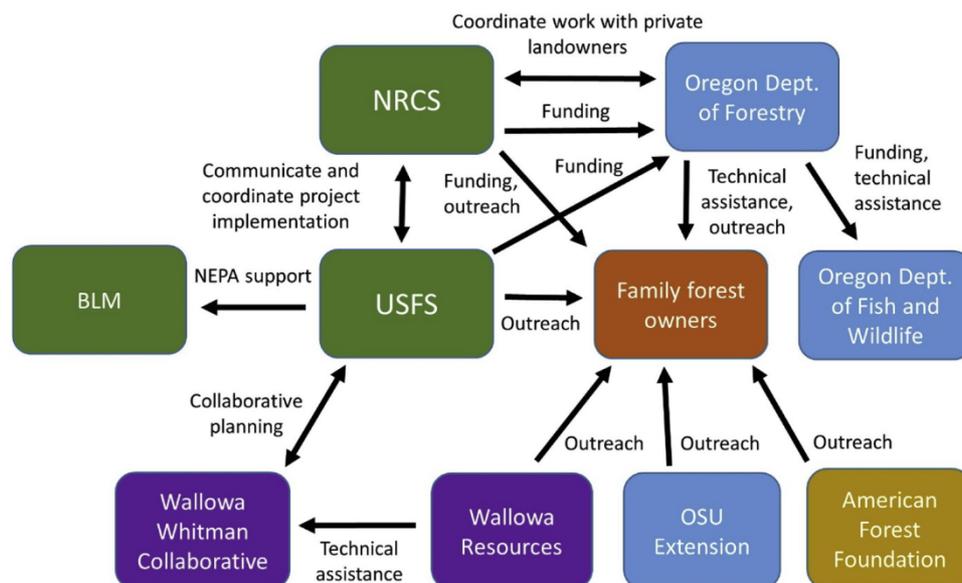


Fig. 3. Model of the network of federal (green), state (blue), national NGO (mustard), regional/local (purple), and family forest owner (orange) actors in the East Face of Elkhorn Mountains project.

3.2.2. Constraints

We found no evidence that family forest owners coordinated with each other to plan and implement treatments across their ownerships, or coordinated directly with their public lands neighbors. Other system actors (principally ODF) conducted outreach to individual landowners, and the “wheel and spoke” model of technical assistance prevailed, with a central figure in the network – the ODF forester – working with landowners individually to plan treatments. The ODF was an important liaison in the system, representing the interests of family forest owners to public landowners and providing the capacity needed for them to accomplish treatments. However, there was limited relationship building between family forest owners and federal and state landowners, and lack of direct coordination between family forest owners and their neighbors (private or public) in fuels reduction.

Another limitation was lack of engagement in the project by the one private corporate owner with land in the project area. Reasons for lack of engagement given by the interviewee representing this ownership were lack of USFS plans to treat along their shared property boundary, creating a disincentive to treat on only one side of the border; lack of external financial support – neither the USFS nor the NRCS had ways to move money to this owner – and there was no other leveraging of funds by partners; and lack of time to attend collaborative group meetings and engage with partners because of a feeling that the cost/benefit ratio would be unfavorable. Outreach to this owner by actors in the network was also limited, and relationships with most of them weak or non-existent.

3.3. Middle Klamath River Communities Project

The Klamath project, located in the Klamath River watershed in northwestern California, also received Joint Chiefs funding in 2014. Land management in the mid-Klamath region is overwhelmingly under federal control, with 95% federal (managed by the USFS), and only 5% in private ownership (mainly family forest). The project area is mostly in the Klamath National Forest (KNF) and comprises part of the ancestral lands of the Karuk Tribe, which has been an important partner in management projects on the KNF. This remote area has experienced chronic, severe wildfire activity with health and socioeconomic impacts on local communities, and in response, there has been a local effort to restore fire resilience across the region. This has occurred in part through the reintroduction of fire, and revitalization of the “human-fire relationship” that broke with fire suppression and Euro-American settler ignorance of the role of fire in Native American-managed western landscapes.

Collaborative burn projects on USFS lands started in the 1990s between the KNF and the Karuk Tribe. The Tribe also became involved in habitat restoration for tribal trust resources (e.g., coho salmon) on federal lands spanning the KNF and the neighboring Six Rivers National Forest (SRNF). Subsequent collaborative work between the Tribe and the USFS has been rocky at times, with USFS decision-making described as a “black box” by one tribal member. Nevertheless, a partnership developed in 2007 between the Karuk Tribe, Mid Klamath Watershed Council, the KNF, the SRNF, and other partners. This effort initially focused on instream restoration of salmonid habitat, but beginning in 2013, professional facilitation through a series of workshops by TNC created an inclusive environment for addressing upslope forest restoration. This partnership, later termed the Western Klamath Restoration Partnership (WKRK), formed out of these workshops, and grew to include the watershed-based Salmon River, Orleans-Somes Bar, and Happy Camp Fire Safe Councils¹, the Salmon River Restoration

¹ The California Fire Safe Council, which is now an NGO, was initially established by the California Department of Forestry to provide outreach and education to landowners about managing wildfire risk, and to facilitate grant funding between federal partners and local landowners to reduce it. Local Fire

Council, U.S. Fish and Wildlife Service, the Environmental Protection Agency, forest industry, and TNC. The Klamath area Fire Safe Councils engaged family forest owners, the Karuk Tribe, and the USFS to coordinate “Firewise” events to bolster wildfire community preparedness. TNC partnered with the Mid Klamath Watershed Council, the Karuk Tribe, and Salmon River Restoration Council to organize Prescribed Fire Training Exchange (TRES) programs in the region. WKRK provided resources and supported planning of fuels treatments on the national forests.

The Mid-Klamath region was selected for a Joint Chiefs project because of its previous success in carrying out collaborative forest management work, including work undertaken by the WKRK. The Joint Chiefs project area was smaller than the regional WKRK footprint (which covers almost 500,000 ha), but lay within this footprint, and largely focused on federal land on one national forest, the KNF. Goals of the Klamath project included (a) ecosystem restoration, (b) creating communities more resilient to wildfire events, (c) upholding values associated with local tribal culture, wildlife, and watershed enhancement, and (d) creating employment opportunities. Treatment locations were prioritized to create fire-resilient communities and landscapes, while “additional funding [was to] be used to accelerate implementation of the highest priority projects” (USDA, 2016). In 2016, when the Joint Chiefs funding ended, the KNF had treated hazardous fuels on about 1700 ha and along 43 km of road with project and other associated monies, and treatments were planned on about 2200 additional ha (USDA, 2016).

On private lands, the NRCS intended to support treatments on about 1000 ha over the three-year period, but NRCS funding ceased after 2015. At that time, the agency lost the forester who had been working on the project. Up to that point, treatments had been completed on 150 ha of private lands, with just over \$360,000 (a fraction of the potential total) spent. Table 5 and Fig. 4 display the relationships between, and roles of, actors in the Klamath project.

3.3.1. Enabling factors

- Building on previously-developed partnerships

The middle Klamath River region has a long history of working through partnerships to overcome distrust, evidenced by the formation of the WKRK and the working relationship between the Karuk Tribe and the KNF. The WKRK, which involved a wide array of partner organizations, had actors operating at multiple scales, with local (Fire Safe Councils), regional (Mid Klamath Watershed Council), and tribal (Karuk) partners, as well as national groups such as the USFS and TNC engaged. All of these organizations agreed to a set of shared values, which included creating fire-adapted communities and restoring historic fire regimes. The Klamath project emerged from this pre-existing network of partners with a focus on reducing wildfire risk in one portion of the larger WKRK boundary area.

- Coordination among actors

Prior to losing capacity and funding during the last year of the project, NRCS worked with non-federal partners who were part of the WKRK (including the Karuk Tribe, Mid Klamath Watershed Council, and Fire Safe Councils) to conduct outreach to family forest owners. TNC, with multiple educational, facilitation, and outreach programs, served a vital role in bringing capacity to family forest owners to implement fuels reduction and prescribed fire programs. Many of these efforts occurred outside Joint Chiefs funding, but they contributed to a

(footnote continued)

Safe Councils, developed through grassroots, community-based organizing, have since flourished across the state.

Table 5
Key actors in the Middle Klamath River Communities project and their roles.

Actor	Type	Role
<i>National</i>		
Forest Service	Federal agency	Planned and implemented fuels reduction treatments on 1700 ha and along 43 km of road in the KNF, with more treatments planned; coordinated with NRCS to implement the Joint Chiefs project; provided funding from leveraged sources to family forest owners to conduct treatments
NRCS	Federal agency	Provided cost-share funding to family forest owners for fuels treatments; provided forester to plan treatments on family forest lands; coordinated with USFS to implement Joint Chiefs project
The Nature Conservancy (TNC)	National NGO	Funded regional groups (Orleans-Somes Bar Fire Adapted Communities, Western Klamath Fire Learning Network) as part of its nationwide US Fire Learning Network; provided personnel, facilitation, expertise and other resources to WKRP to enable meetings and joint planning; implemented prescribed fire treatments on non-federal lands and provided training to local residents to be proficient in its use through the TREC program (<i>outside of Joint Chiefs project</i>)
<i>Tribal</i>		
Karuk Dept. of Natural Resources	Tribe	Implemented fuels reduction projects on federal lands prior to Jt. Chiefs project; was an important partner organization with the Mid Klamath Watershed Council to create the WKRP
<i>Regional</i>		
Mid Klamath Watershed Council	Regional NGO	Served as a liaison to NRCS for contacting landowners in rural locations; assisted NRCS in planning and implementing fuels reduction projects on private lands; conducted outreach and provided education and training to landowners; co-hosted TREC, implementing prescribed burns on private lands in the Joint Chiefs project area, including on NRCS Joint Chiefs treatment areas.
<i>Local</i>		
Family forest owners	Local landowners	Applied for cost-share funding through NRCS to conduct fuels treatments on their properties (~ 150 ha); worked with area Fire Safe Councils and NRCS forester to plan and implement treatments
Salmon River, Orleans-Somes Bar, and Happy Camp Fire Safe Councils	Local NGOs	Supported community-based efforts to reduce wildfire risk on private lands; worked with NRCS to conduct outreach to family forest owners, and provided technical assistance to them

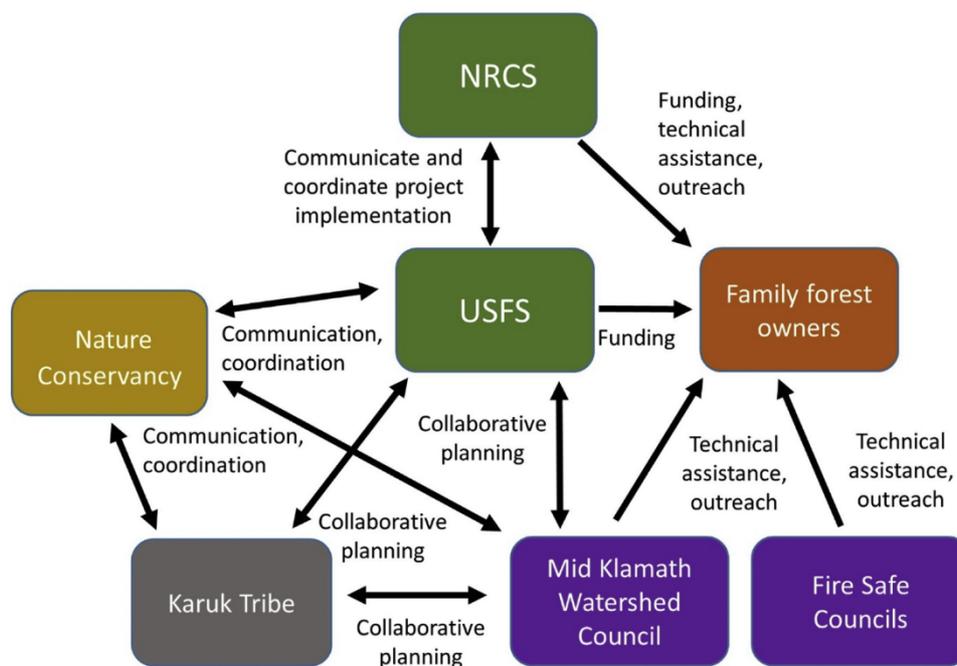


Fig. 4. Model of the network of federal (green), tribal (gray), national NGO (mustard), regional/local (purple), and family forest owner (orange) actors in the Middle Klamath River Communities project.

better understanding of the role of re-introducing fire to the landscape among landowners and stakeholders across the mid-Klamath region, and increased treatment acreage on family forest lands.

3.3.2. Constraints

The Joint Chiefs portion of the broader mid-Klamath regional restoration project was developed largely without input from partners in the WKRP (which more closely resembled a functional polycentric governance system than the Joint Chiefs project). From partners' perspectives (such as the Karuk Tribe and Mid-Klamath Watershed Council), the Klamath project was pursued unilaterally by the KNF, with minimal input from WKRP partners. It was also seen as a funding mechanism for accomplishing NEPA-ready projects developed by the

KNF. Once Joint Chiefs funding was awarded, partners indicated they were not effectively recruited to participate in the project, and only minimally involved in project implementation. This failure to collaborate was described by one interviewee as a "missed opportunity." The KNF's reversion to top-down governance may have been effective for accomplishing work on KNF lands, but it limited coordination with private lands treatments in the context of ALM, and undermined the trust built through previously-established relationships with other actors in the system, straining relationships between the KNF and partners. In particular, interviewees expressed concern that the Karuk Tribe, which had previously shared information with the KNF about desired conditions across its ancestral lands, was not engaged in all phases of the Joint Chiefs project. This meant that the KNF used

information that incorporated tribal knowledge without substantial tribal involvement in the projects.

For its part, the NRCS did not have strong links to the WKRP, perhaps because the NRCS had only recently begun working with family forest owners in the region. This may be partly because the Klamath region is extremely remote and landowners are dispersed across great distances (most land is federal). There is also very high absenteeism among family forest owners in the area (unpublished survey data). Additionally, many family forest owners cannot work with NRCS because of federal policies prohibiting cannabis cultivation, a common land use in the region. WKRP Partners helped conduct outreach to family forest owners about the opportunity to obtain cost-share funding for fuels treatments through NRCS after Joint Chiefs money became available. However, NRCS relied primarily on its locally-based forester to provide family forest owners with the technical support needed to obtain funding and plan treatments. This was especially challenging because many landowners do not have the forest management plans necessary for working with NRCS, and must first develop them. When NRCS lost its local forester part way through the project, the nearest NRCS forester had an office located 80 km away. Thus, NRCS lacked sufficient staff to work with landowners, and also lacked the capacity to outreach to other actors in the system to obtain assistance with project planning and implementation. In this case, with a sudden influx of funding but very little established capacity, and tenuous connections to the existing polycentric governance system established under the WKRP, NRCS was left with few options for successful project implementation. It consequently lost funding that could have otherwise been spent on cost-sharing treatments on family forest lands in the project area.

There was also an absence of participation from state-level agencies, important in the other two cases. We are unsure what caused this absence, but it left a gap at one scale of the polycentric governance system that might have otherwise provided the needed capacity to support other system actors – such as NRCS when it lost its local forester. This gap underlines the value of redundancy in polycentric systems.

4. Discussion

4.1. Characterizing polycentric wildfire governance systems

The Joint Chiefs Partnership created a formal program with funding to support ALM; in our cases, reducing wildfire risk in multi-jurisdictional landscapes. Through coordinating wildfire risk management across different land ownerships and scales, polycentric wildfire governance systems emerged. The three case studies presented here provide examples of how polycentric wildfire governance systems form and operate. Each describes how actors self-organized to apply for and develop a Joint Chiefs project in response to a funding incentive, and to plan and implement fuels reduction activities. Each case displays key attributes of polycentric systems:

- 1 Multiple and diverse actors working at different scales to formulate and implement rules or policies within a specified domain or geography

Our cases describe the roles of different public and private actors operating across scales to develop and implement wildfire risk reduction activities within the common framework and geography of their respective Joint Chiefs projects (Tables 3–5). These actors brought different skills, capabilities, resources, obligations, and constraints to the Joint Chiefs projects. Actors played nested roles across governmental levels and across scales, with higher level (e.g., federal, national-level) actors participating in broad funding and planning decisions, and lower level (e.g., municipal or regional) actors serving to interpret and implement policies on the ground.

- 2 Overlapping centers of power that extend across jurisdictions and create redundancy

Property regimes impact how resource decisions are made, and the multi-jurisdictional landscapes we studied contain inherently autonomous land ownerships. For example, federal land managers are ultimately responsible for decision-making on USFS and BLM lands, and private (corporate and family forest) landowners are responsible for management decisions on their lands. However, our cases illustrate how governmental and non-governmental actors participated in wildfire risk reduction activities that extended beyond their respective jurisdictions by (a) working on landscape-level and coordinated planning that pulled together authorities from different jurisdictions, (b) giving voice to actors on ownerships outside their formal authority, and (c) conducting or directing work on projects outside the boundaries of their traditional jurisdictions, through sharing and distributing funds, working on permitting (e.g., NEPA), and helping to implement and monitor projects. This created multiple centers of power, sometimes vested in collaborative groups, sometimes in NGOs, and sometimes with individual landowners or land managers, to get wildfire risk reduction projects planned and implemented. Having some functional redundancy among entities increased system resilience by enabling different actors to fulfill different roles when a given actor temporarily lacked capacity to carry out a particular activity itself.

- 3 Interaction among actors to share resources, communicate, coordinate, and cooperate

Our cases clearly illustrate many examples of interaction between actors in the polycentric governance system associated with each Joint Chiefs project (Figs. 2–4). These actors consisted of different constellations of federal and state agencies, NGOs, Tribes, and private landowners, depending on the site. Interactions between some actors in each case preceded the establishment of the Joint Chiefs projects, although at least two of the projects increased opportunities for interaction (see also Schultz et al., 2018). In responding to the Joint Chiefs program, actors self-organized into groups to apply for project funding. Once they received funding, they interacted to share resources, which was critical for enhancing one another's capacity to implement wildfire risk reduction across ownerships. Actors worked together cooperatively to reduce wildfire risk, such as through planning exercises, joint agency decision-making, and coordinating management across jurisdictions. Communication and coordination between actors was often facilitated by specific entities (e.g., TNC) or forest collaborative groups (e.g., the Wallowa Whitman Collaborative).

- 4 An overarching set of rules within which actors operate

All of the actors in our cases operated under the overarching set of rules associated with the Joint Chiefs program, which directed how two federal agencies (USFS and NRCS) should work together to develop and implement forest restoration projects across federal and private lands. Once they obtained funding, each agency worked within its respective regulatory authorities to figure out how to coordinate with partners and share resources across ownerships to accomplish wildfire risk reduction. Actors also operated according to informal rules regarding how to work across ownership boundaries, self-govern (e.g., creating a leadership structure), and share decision-making. These rules differed somewhat by location and were developed through interactions among actors.

- 5 The ability to influence each other's decisions and jointly affect collective costs and benefits

As we have argued, wildfire risk reduction is a collective action problem because forest and fire management on one land ownership

affect wildfire risk on neighboring ownerships. Thus, the forest and fire management decisions of actors in multi-jurisdictional landscapes influence the collective costs and benefits of land management. Tables 3–5 illustrate how actors worked together to influence each other's land management decisions, and create benefits and decrease costs associated with reducing wildfire risk. The establishment of forest collaboratives since the 1990s has created new mechanisms for actors to influence federal land management. ALM expands this ability to other land ownerships, at least in principle; for example, when diverse landowners participate and coordinate decision-making on their properties. And although NRCS and state agencies have historically worked with family forest owners to provide financial and technical assistance, our cases show how they collaborated and coordinated in new ways and with new partners to do so, although not always successful.

The polycentric governance systems described in our cases allowed diverse landowners and stakeholders to be incorporated into ALM across a broader landscape. Although all three cases display polycentric governance systems, some functioned better than others to accomplish fuels treatments, with room for improvement in performance. Below we consider how to create more effective polycentric wildfire governance systems based on the cases and the literature in the hope of improving wildfire risk reduction outcomes.

4.2. Lessons learned for improving polycentric wildfire governance

Lesson 1: Collective action to address joint risk through polycentric governance systems can be strengthened when bottom-up and top-down processes and incentives converge

The “conventional theory” of collective action predicts that coordinated action to address joint risk is unlikely without external (*i.e.*, top-down) control and direction (Ostrom, 2010). However, there are many examples of actors at multiple scales implementing solutions to environmental problems through polycentric systems (Nagendra and Ostrom, 2012; Ostrom, 2010). We found in all of our cases that the need for collective action to address wildfire risk reduction was being partly addressed in place, from the bottom up, at neighborhood, watershed, and regional levels before federal ALM policies and incentives were introduced. While groups can self-organize to address a resource management problem, they can also benefit from centralized (*e.g.*, federal) funding incentives, and from nested institutional support, especially to create authorities that cross jurisdictional lines. Federal policies and incentives for working across public and private land ownerships, such as the Joint Chiefs Partnership, help to build and support emergent polycentric systems for wildfire governance. But Joint Chiefs projects would likely not have been selected for funding had there not been pre-existing, self-organized, local groups with a track record of collaboration in forest management. Our finding that polycentric governance systems emerge through both top-down and bottom-up processes is not unique (Baldwin et al., 2018; Pahl-Wostl, 2009). When top-down processes (including incentives and policy structures) and bottom-up processes (including capacity and relationship building) converge and reinforce one another, polycentric governance systems are likely to be stronger and more effective at addressing a collective action problem.

Lesson 2: There is a need for effective communication and coordination among actors within the system

Communication and coordination are central components in bringing top-down and bottom-up processes together. Other authors have identified the need for an effective coordination structure among actors within the system for successful polycentric governance (Pahl-Wostl, 2009; Pahl-Wostl and Knieper, 2014). In many cases, the “roles, rights, rules, technologies, and infrastructure” for broad-scale forest management may already be in place, but not yet coordinated effectively (Bixler, 2014, p. 165). Our cases clearly demonstrate that ALM operates by coordinating among multiple actors at multiple scales, and creating both vertical and horizontal linkages across scales. A key

component of this is communication between scales. This was achieved in our cases through the presence of NGOs such as TNC that focused on facilitating communication among state and federal agencies, collaborative groups, and landowners. In terms of horizontal linkages, local collaborative groups, such as the Willowa Whitman Collaborative in the East Face case, and the Ashland Forest Resiliency partners in the Ashland case, played an important role in facilitating communication and coordination between actors. While WKRP partners (in the Klamath case) were only minimally involved in the project, they also facilitated communication once brought into it. Others have found that institutional stability over the long term helps promote effective coordination (Ostrom, 1998). This stability can be enhanced by the establishment of formal agreements, such as the ten-year Master Stewardship Agreement in the Ashland case. Organizational stability also promotes coordination, underscoring the importance of low staff turnover rates. In addition, including partners from the outset of a project can help promote coordination. Identifying mechanisms or entities such as those mentioned here that help improve communication and coordination among actors in the system can help improve performance.

Lesson 3: It is important to enable polycentric governance systems to develop differently in different places in order to allow for flexibility and adaptiveness

There is no template for what a polycentric wildfire governance system should look like; rather, flexibility to adapt to local circumstances and capitalize on organizational strengths is needed. Our three case studies had different partners with different capacities playing different roles. For example, in the Ashland case, a locally-based restoration NGO played a key role in interfacing between federal agencies and family forest owners to accomplish restoration on private lands; in the East Face case, the Oregon Department of Forestry played that same role. As systems self-organize to implement ALM, they will do so with different constellations of actors and in ways that are most appropriate on particular jurisdictions in particular places. It is important not to be overly prescriptive in defining how ALM should be carried out.

Lesson 4: Multiple actors at multiple scales are important for supplementing capacity

Polycentric governance systems for ALM can facilitate better forest management outcomes by distributing responsibilities and capabilities for conducting restoration on different jurisdictions among different actors at different scales. Doing so offsets limitations to management by increasing institutional capacity and resources. Each entity takes on aspects of mobilizing decisions in order to implement (in this case) landscape-level management of wildfire risk. Despite distribution of responsibilities, there is also some overlap and redundancy; Armitage et al. (2007) described polycentric systems as “deliberately redundant” in order to maintain adaptiveness. This is evidenced in our cases by the overlapping organizations conducting outreach with private forest landowners in Figs. 2–4. There are also redundancies in the management of federal lands. For example, both Lomakatsi and the USFS implemented fuels reduction projects on federal lands in the Ashland case (with additional help from the city). Both could also conduct fuels reduction projects on family forest lands, though the USFS had not pursued this yet. In the East Face project area, the USFS undertook NEPA analysis on BLM land. While the BLM can conduct its own NEPA analysis, in this case the USFS did so to facilitate the BLM's ability to conduct treatments more expeditiously.

Our cases illustrate numerous ways in which diverse actors filled the capacity gaps of other entities. One example is the USFS and ODF providing funding and technical expertise to reduce wildfire risk and start a commercial timber operation on ODFW lands that now funds ongoing fuels reduction work on its lands throughout eastern Oregon (East Face). We also saw how the inability to recruit needed capacity, and the absence of key actors as partners (such as any state-level agencies) constrained the NRCS from fully implementing wildfire risk reduction on family forest lands (Klamath). Not only do they enhance capacity, key actors in polycentric systems sometimes serve as the

“glue” that catalyzes projects and keeps them going by bringing together diverse participants to address problems. For example, the TNC played an important role in helping project participants having a history of mistrust come together and move forward in both the Ashland and Klamath cases.

In our cases, diverse actors helped to distribute funds; share information, lessons, and expertise through outreach; conduct restoration; undertake research and monitoring; coordinate stakeholders; and perform other tasks that supplemented and amplified the abilities of federal actors. Different actors at different scales served as “facilitators” (per [Maier and Abrams, 2018](#)), increasing the capacity of the NRCS and USFS, two agencies that have been defunded at the federal level over time and are now competing for resources. There remains a need to identify holes or weaknesses in polycentric governance systems and work to fill them early on by mobilizing actors at appropriate scales who have shared interests and can bring needed skills and capacity.

Lesson 5: There is a need to improve, and increase awareness of, legal and policy mechanisms for making the transfer of funding and authority easier between entities who share a landscape to facilitate restoration work

Actors in our cases all operate within the shared set of rules imposed by the Joint Chiefs Partnership. However, actors also operate within the rules (formal and informal) that govern their individual organizations and jurisdictions. Making these rule sets align to accomplish common resource management goals can be challenging when working across jurisdictions. For example, federal funding in the Joint Chiefs program is dispersed to the USFS and NRCS, who in turn may invest those funds in restoration treatments on other land ownerships. But the ability to transfer funding from one agency to another agency or landowner, and to use federal funds to carry out restoration on non-federal lands, is often cumbersome and not always legally possible. Policy mechanisms to make such transfers easier and promote ALM exist, such as the Good Neighbor Authority and the Wyden Amendment Authority. But these are not necessarily sufficient. Moreover, Joint Chiefs funding is restricted in terms of the land ownerships that can use it. For example, it cannot be used to pay for restoration treatments on private corporate lands. And stipulations such as the bar on providing NRCS cost-share funding to landowners who grow cannabis create limitations, a constraint in the Klamath case. Other mechanisms exist but are underutilized or not widely known. There remains a need to improve the policy mechanisms and legal authorities that enable transfers of resources among partners and landowners in the governance system, and to share information and experiences with using the tools that do exist, to improve performance, coordination, and wildfire risk reduction outcomes.

5. Conclusions

Polycentric systems have been described across a wide range of natural resource management sectors in which there is a common or shared resource, including fisheries, forests, river basins, and aquifers ([Carlisle and Gruby, 2017](#); [Nagendra and Ostrom, 2012](#); [Schröder, 2018](#)). We found that polycentric systems are also emerging in the context of common or shared environmental risk, such as wildfire (see also [Carlisle and Gruby, 2017](#), for transboundary pollution). We argue that polycentric systems are better suited to the task of wildfire risk management than either traditional top-down hierarchical systems on the one hand, or local-level collaborative approaches focused on federal lands on the other. By comparing three Joint Chiefs projects in the western U.S. that include both public and private lands, we have articulated several of the benefits of polycentric systems in this context, such as the ability to leverage resources and capacity among actors for accomplishing wildfire risk reduction, and improved coordination for implementing forest management across land ownerships. But we also identified constraints that have hampered the performance of these systems, such as regulations and policies that make it difficult to share

resources between land ownerships, breakdowns in communication and trust among actors, and holes in the system where strategic recruitment of additional partners could have helped. In identifying lessons learned from the case studies, we hope to help strengthen polycentric wildfire governance systems, and in turn implementation of ALM policies, for better wildfire risk reduction outcomes. Research remains to be done regarding polycentric governance systems in the context of wildfire or other shared risks, including work in locations outside the U.S. Understanding how these systems develop and function successfully is important because many of the natural resource and land management challenges of the 21st century will not be limited to single land ownerships, or single authorities.

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Declaration of Competing Interest

None.

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