Centering socioecological connections to collaboratively manage post-fire vegetation shifts

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Climate change is altering fire regimes and post-fire conditions, contributing to relatively rapid transformation of landscapes across the western US. Studies are increasingly documenting post-fire vegetation transitions, particularly from forest to non-forest conditions or from sagebrush to invasive annual grasses. The prevalence of climate-driven, post-fire vegetation transitions is likely to increase in the future with major impacts on social–ecological systems. However, research and management communities have only recently focused attention on this emerging climate risk, and many knowledge gaps remain. We identify three key needs for advancing the management of post-fire vegetation transitions, including centering Indigenous communities in collaborative management of fire-prone ecosystems, developing decision-relevant science to inform pre- and post-fire management, and supporting adaptive management through improved monitoring and information-sharing across geographic and organizational boundaries. We highlight promising examples that are helping to transform the perception and management of post-fire vegetation transitions.

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In a nutshell:

- As the western US dries and warms under a changing climate, leading to larger and more frequent severe wildfires, some areas have experienced shifts in post-fire vegetation (eg forests being replaced by grassland or shrubland)
- These changes are leading to difficult questions about how to manage fire-prone landscapes: should anticipated changes in resident plant communities be resisted, passively accepted, or actively directed?
- We provide helpful examples of the kinds of information, coordination, and values needed to manage these changes ethically and effectively as they become more common in the face of climate change

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Across much of the western US, climate change is driving increases in the area burned, fire frequency, and in some cases fire severity (Abatzoglou and Williams 2016; Parks and Abatzoglou 2020). Similar patterns are also seen in many other regions around the world (Ellis *et al*. 2022). Altered fire regimes—combined with warm, dry, post-fire conditions—are expected to accelerate ecological transformations and vegetation type conversions, which we define as "major, extensive, and enduring changes in dominant species, life forms, or functions" (Coop *et al*. 2020). For example, studies are increasingly highlighting post-fire vegetation shifts from forest to non-forest conditions or from shrub-dominated to invasive annual-grass–dominated systems (Figures 1 and 2; Chambers *et al*. 2019; Jackson 2021; Guiterman *et al*. 2022). These transitions are predicted to increase in the near future, with substantial impacts on ecosystems and the human communities that depend on them (Coop *et al*. 2020).

Despite evidence that vegetation transitions are an important climate risk (Coop *et al*. 2020; Jackson 2021; Guiterman *et al*. 2022), land management policies and practices have yet to adapt to this new era of rapid environmental change. This is partly due to current institutional and social constraints, as well as limited information on the effectiveness of available strategies for managing ecological transformation in the face of uncertainty (Jackson 2021; Clifford *et al*. 2022). In combination, land management legacies, forced relocation of Indigenous peoples, criminalization of cultural burn practices, and changing climatic conditions have led to increasingly unpredictable post-fire ecological outcomes that challenge dominant land management policies and practices based on the recent past (Hessburg *et al*. 2021). While some

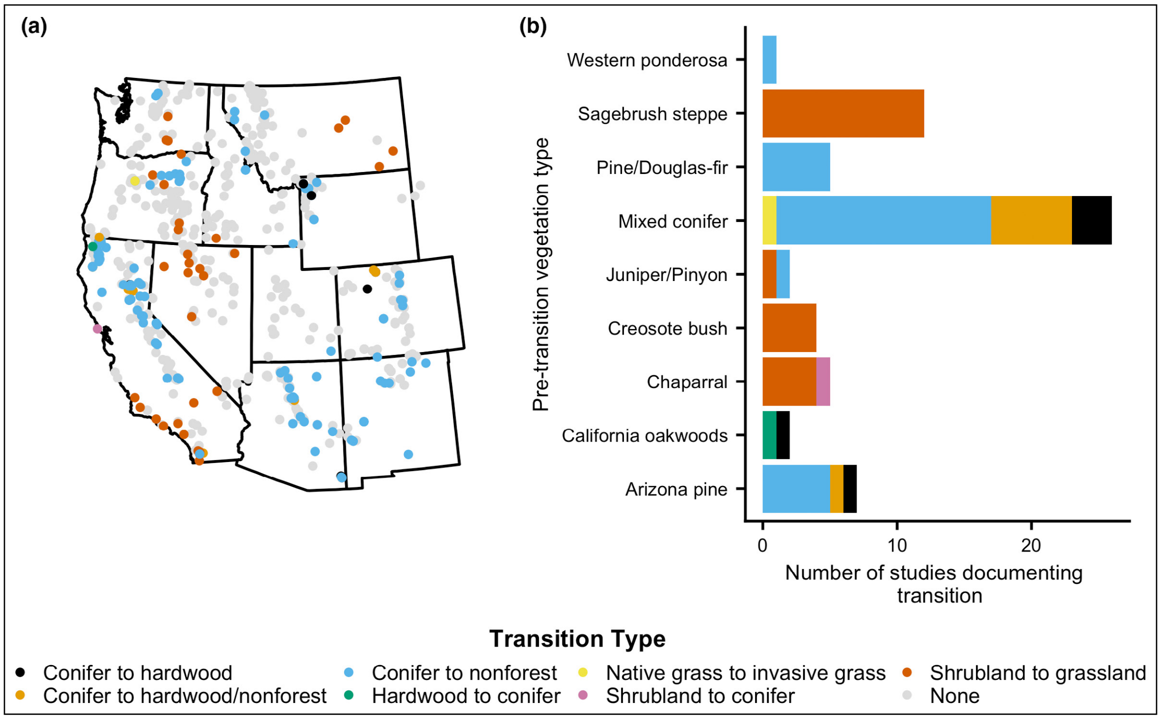

Figure 1. Locations of 318 published studies (through 2020) across the western US that documented (a) post-fire vegetation transitions as defined by the authors of the studies (64 studies; colored circles) and (b) the pre-transition vegetation type at the study location. Locations of studies that occurred across larger spatial extents (eg across a National Forest) are approximated. Studies that documented a post-fire vegetation transition at one sample site did not necessarily observe transitions at all sample sites. The map in (a) only reflects peer-reviewed—and primarily ecological—studies, and therefore not all post-fire transition events are represented. For more information, see https://drewlyons.shinyapps.io/fire_map.

promising new frameworks and approaches that could help address these issues have emerged (eg Figure 3; Marks-Block and Tripp 2021; Stevens *et al.* 2021; Larson *et al.* 2022; Schuurman *et al.* 2022), these have yet to be widely adopted. Widespread adoption of such approaches will require embracing multiple ways of knowing, disrupting power dynamics that in the past led to the exclusion of Indigenous groups from management decisions, and acknowledging that assumptions from the past may not hold in transforming ecosystems (McBride *et al.* 2017; Marks-Block and Tripp 2021; Schuurman *et al.* 2022).

Cultural knowledge—also described as traditional knowledge (TK), Indigenous knowledge (IK), or place-based knowledge of Indigenous communities—is deeply rooted in the social and ecological needs of each community. For example, Indigenous communities have shaped fire regimes by altering the seasonality, frequency, location, and type of fire in diverse ways on their socioecological landscapes (Long *et al.* 2021; Lake 2022; Copes-Gerbitz *et al.* 2023). In this way, Indigenous communities are at the center of historical fire regimes, in some cases even decoupling the relationship between climate and fire (Roos *et al.* 2022). To understand and manage vegetation transitions in the context of climate change, collaborative ecosystem management should consequently be centered around the knowledge and needs not only of that ecosystem and its local communities but also of the Indigenous communities that have tended it for countless generations (Figure 3; Panel 1).

For effective management of post-fire vegetation transitions, we—in this paper—identify three key needs based on a synthesis of the literature and our collective experiences leading and participating in working groups, trainings, and other collaborative efforts supporting scientists, communities, and land managers as they address this emerging adaptation challenge. These needs include centering Indigenous communities in collaborative management of ecosystems, developing decision-relevant science to inform management of post-fire vegetation transitions, and supporting adaptive management through improved monitoring and information-sharing across geographic and organizational boundaries. Although we focus on the western US, many of our recommendations will be relevant globally. These recommendations build on promising examples that can catalyze necessary changes in how we address climate-driven, post-fire vegetation transitions.

Centering Indigenous communities in collaborative management of fire-prone ecosystems

While the Western scientific and landscape management community frequently examines the role wildfire has played in shaping ecosystems of the western US, it rarely highlights the key role human-directed fire has played for millennia and continues to play in shaping these culturally modified fire regimes (Lake *et al.* 2017; Wynecoop *et al.* 2019; Long *et al.* 2021; Lake 2022; Roos *et al.* 2022). In such regimes, Tribal communities apply complex systems of cultural knowledge and stewardship to manage ecosystems (Lake 2022). TK shared through communication and collaboration with local communities (eg via oral tradition, cultural practices, or historical record) offers insight into historical fire regimes and the role Tribal communities have had and continue to have in shaping those regimes (Kimmerer and Lake 2001).

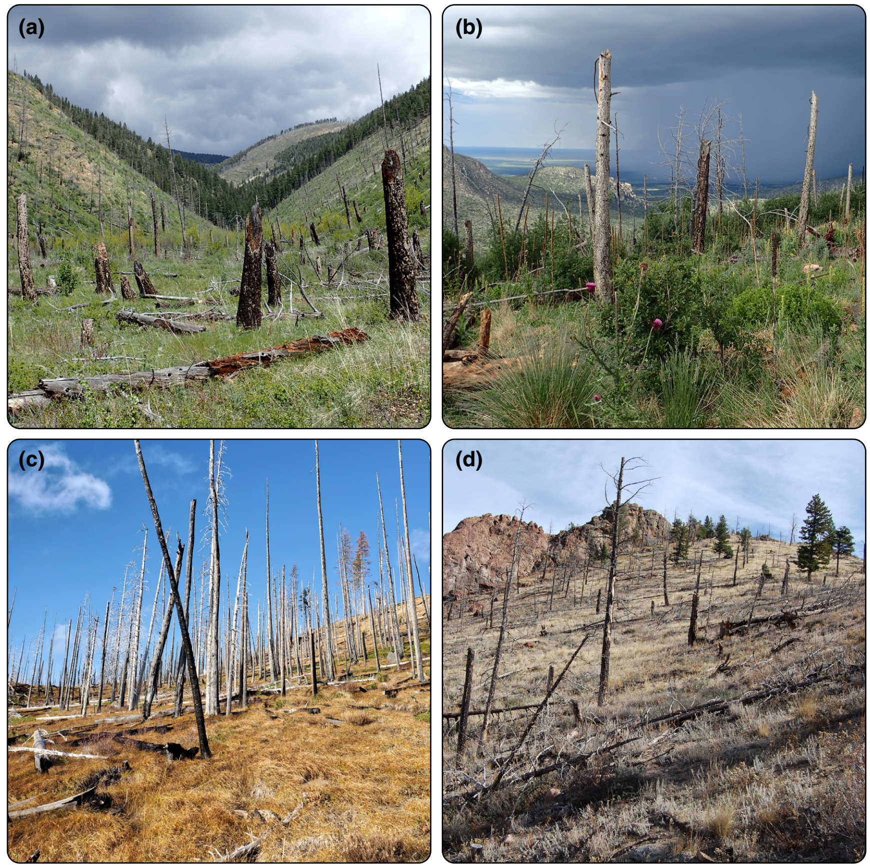

Figure 2. Examples of potential post-fire vegetation transitions across the western US. Sites were previously dominated by mixed conifer forests and display no conifer tree regeneration 10–17 years post-fire but instead are dominated by shrub and/or grass species. (a) Western Montana, (b) south-central New Mexico, (c) southwestern Washington Cascades, and (d) Colorado Front Range. Image credits: KT Davis (a & b), KB Swensen (c), and W Foster (d).

Yet centering TK and Indigenous communities (ie moving them from the margins to play focal roles in decision making) runs counter to the professional norms and institutional and incentive structures under which scientists and land managers operate (Lacey *et al.* 2015). Western land management policies have been largely built on environmental principles that reduced human influence to that of an external actor rather than as a co-creator of landscape conditions (Mason *et al.* 2012; Boyd 2022). Framings of humans as separate from landscapes, along with ongoing colonization and systemic racism, have attempted to erase the essential role Indigenous peoples have played in their local ecosystems, as well as the reciprocal role fire-adapted ecosystems play in the mental, physical, and spiritual well-being of Indigenous communities (Mason *et al.* 2012; Long *et al.* 2021).

While Western science and management often ignore cultural aspects of ecosystem processes, TK recognizes that ignoring or removing socioecological connections from management decisions harms both communities and their ecosystems (Mason *et al.* 2012). For example, Tribes are writing climate adaptation plans that strengthen connections between fire and fuels management and cultural and natural resources (eg CSKT 2016; CTUIR 2022). Reconnecting communities to fire-use on the land requires dialogue within an ethical space of engagement (Ermine 2007) that elevates the authority of TK, acknowledges the fundamental differences between environmental stewardship and resource management pathways, and actively pursues reconciliation for pervasive injustices and inequalities (Wong *et al.* 2020). Centering the TK of Indigenous communities into contemporary fire, fuels, and post-fire management therefore requires consistent, cross-jurisdictional communication and collaboration to build respectful and reciprocal relationships (Mason *et al.* 2012; Lake *et al.* 2017). Successful partnerships occur when the social and ecological needs of Indigenous communities are prioritized as opposed to when cultural knowledge is appropriated by non-Tribal agencies (Mason *et al.* 2012; Johnson *et al.* 2016; Wong *et al.* 2020). Frequent interagency communication and training throughout the year provides opportunities to build trust across jurisdictions, standardize regional monitoring protocols, share landscape-level data, and integrate TK into regional best practices that protect community resources without compromising sensitive cultural information. Methods such as centering Indigenous communities in participatory geographic information system (GIS) mapping activities of cultural burning (Wynecoop *et al.* 2019) and guiding principles such as "two-eyed seeing" (www.integrativescience.ca/Principles/TwoEyedSeeing; Bartlett *et al.* 2012), which promotes equitably embracing multiple ways of knowing and co-learning, can help inform pre- and post-fire management decisions and steer the development of complex, cross-jurisdictional, and culturally sensitive strategies for collaboratively managing post-fire vegetation transitions. For example, participatory GIS allows TK holders to share information that can help link management treatments to the broader cultural context without jeopardizing confidentiality (McBride *et al.* 2017).

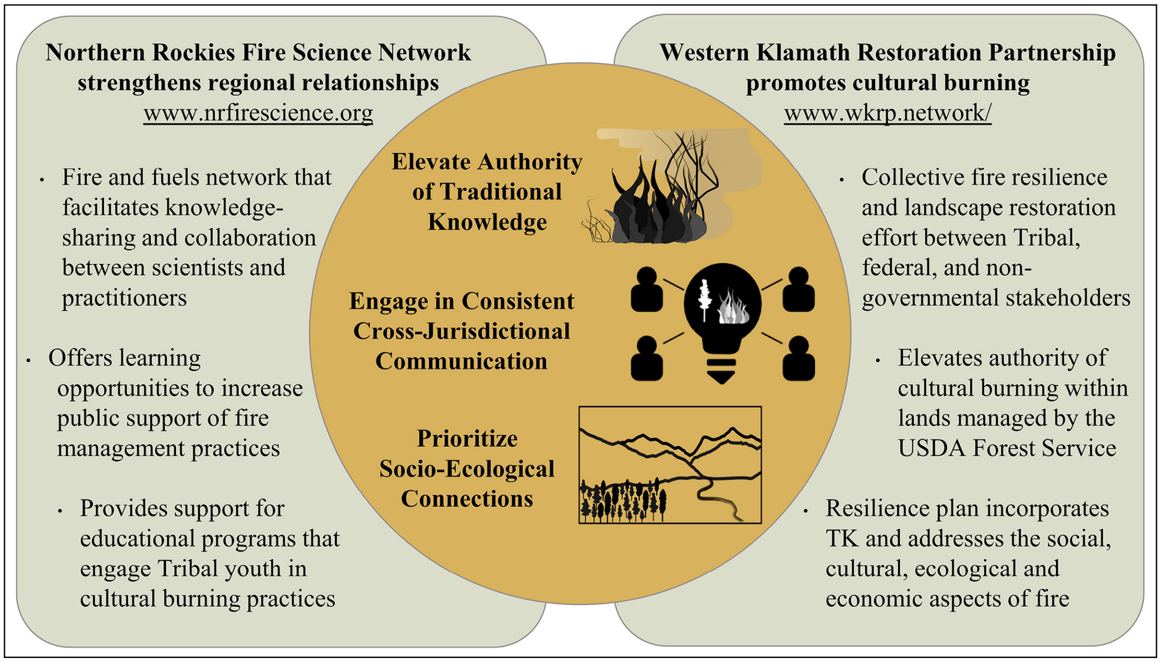

Figure 3. Centering the knowledge and practices of Indigenous communities in the collaborative management of fire-prone ecosystems requires partnerships to intentionally elevate the authority of traditional knowledge (TK), prioritize socioecological connections, and engage in consistent cross-jurisdictional communication. In sharing knowledge and managing fire-prone ecosystems, the Northern Rockies Fire Science Network and the Western Klamath Restoration Partnership are two examples of cross-jurisdictional collaborations that are working toward centering the knowledge, needs, and practices of Indigenous communities.

Panel 1. East Jemez Landscape Futures Collaborative

To collaboratively manage post-fire landscapes, the East Jemez Landscape Futures Collaborative oversees projects that bridge Western science, Indigenous knowledge, and the priorities of local Pueblos and communities. The Collaborative represents a knowledge-sharing and decision-making network for land managers, community members, and researchers in the eastern Jemez Mountains of New Mexico. Its goal is to develop "concrete, action-oriented strategies that are scientifically based and culturally appropriate" within an adaptive management framework that uses the concepts of the resist–accept–direct framework (Lehnert *et al.* 2021).

An example project under the Collaborative was *Las Conchas reforestation*, a post-fire reforestation project conducted within areas burned at high severity by the 2011 Las Conchas fire. The Las Conchas reforestation project:

- involved the nonprofit organization Trees, Water, and People (https://treeswaterpeople.org/new-mexico); partners from the Tri Pueblo Coalition (Cochiti, Jemez, and Kewa Pueblos); and researchers from universities and federal agencies (Calabaza 2022);
- utilized Western science to identify where reforestation may be more successful based on climate conditions (ie "more suitable" areas);
- relied on local Pueblo knowledge and priorities to decide which of the "more suitable" areas should be selected for planting and which culturally important species should be planted;
- experimented with new reforestation strategies and monitored the success of the planting efforts to inform future decisions; and
- conducted planting and monitoring by Native technicians and worked to engage Tribal youth in reforestation activities.

Collaborative management of fire-prone ecosystems also requires cross-jurisdictional communication and knowledge-sharing to meet the information needs of Tribal and non-Tribal managers as they prepare for and respond to vegetation transitions. Networks such as the Prescribed Fire Training Exchanges (https://firenetworks.org/trex; Figure 4; Panel 2), Fire Learning Network (https://firenetworks.org/fln), Indigenous Peoples Burning Network (https://firenetworks.org/ipbn), Collaborative Forest Landscape Restoration Program (https://www.fs.usda.gov/restoration/CFLRP), and Burned Area Learning Network (https://tinyurl.com/28k-pz9s7) are examples of efforts to share experiences and foster cooperation across agencies and communities that could include management of post-fire vegetation transitions (Butler and Goldstein 2010; McIntyre and Schultz 2020; Marks-Block and Tripp 2021). Boundary-spanning organizations like the

Panel 2. Indigenous Women-In-Fire Training Exchange (WTREX)

The Indigenous Women-In-Fire Training Exchange (WTREX) elevates underrepresented fire practitioners in prescribed burning training and knowledge-sharing. A training event hosted by the Karuk Tribe, local partners, and members of the national WTREX is pictured in Figure 4. Such events center local and Indigenous knowledge in prescribed and cultural burning training for interagency fire practitioners; promote shared learning spaces that draw on the experiences and perspectives of all participants; and elevate the voices of underrepresented fire practitioners and apply their expertise to manage diverse ecosystems and fuel types on Tribal, federal, and private lands.

Figure 4. Participants in the Indigenous Women-In-Fire Training Exchange conduct a prescribed burn. Image credit: M Finlayson.

Fire Science Exchange Network also provide opportunities for managers to learn about emerging management strategies from one another, for instance through field tours (https://www.nrfirescience.org/sites/default/files/NRFSN_FTSummary_13_CSKTFieldTrip_0.pdf) and workshops (https://www.nrfirescience.org/event/selway-bitterroot-wilderness-and-frank-church-river-no-return-wilderness-fire-science). These platforms distribute information across social and ecological scales and serve as forums for Tribal and non-Tribal managers to share their valuable perspectives and experiences with stewarding ecosystems in an era of climate, wildfire, and vegetation change.

While offering the potential for more holistic management of post-fire vegetation transitions (Moritz *et al*. 2014), collaboration and knowledge-sharing also come with challenges. In cross-jurisdictional landscapes, collaboration may be unable to fully influence key decisions and decision makers. This lack of influence stems from incompatible priorities and regulatory constraints (eg treaty-bound management barriers in Tribal lands); conflicting community, resource management, and policy operational timescales; and a lack of funding to support management actions (Mason *et al*. 2012; Marks-Block and Tripp 2021). In response, collaborative agreements among government agencies, nongovernmental organizations, Tribes, and community stakeholders established prior to a wildfire can support knowledge integration and promote co-management of federally owned ancestral lands. For example, interagency partnerships—such as the Western Klamath Restoration Partnership among the Karuk Tribe, the Mid Klamath Watershed Council, the US Forest Service, and other community-based groups—can increase the capacity for actions like prescribed and cultural burning (Figure 3; Marks-Block and Tripp 2021). In addition, building trusting relationships with mutual support between agencies and communities before a wildfire occurs can help increase social acceptance of post-fire management actions (Olsen and Shindler 2010). Promoting such partnerships requires strategic investment in capacity for collaboration (Yung *et al*. 2022), which can be achieved through coordination funding and participation incentives to develop and expand regional networks across knowledge communities. In addition, training scientists and natural resource managers to effectively foster trust, communication, and collaboration with relevant communities will be important in establishing long-term relationships to help address and respond to future landscape changes (MacMillan *et al*. 2019; Rozance *et al*. 2020).

Developing decision-relevant science to inform management

Land management agencies and individual land stewards increasingly recognize the importance of accounting for the risk of post-fire vegetation transitions; however, they are limited by a lack of information not only around where, when, and how such transitions may occur but also on the effectiveness of prior and new or alternative responses (Clifford *et al*. 2022; Crausbay *et al*. 2022). This presents an urgent need for decision-relevant science that bridges multiple knowledge systems to inform robust management decisions in rapidly changing landscapes (Johnson *et al*. 2016; Glenn *et al*. 2022).

Acknowledging and elevating the importance of past and ongoing socioecological connections in landscapes of the western US may improve the ability to make ethical and effective management decisions in the face of rapid change by questioning the idea that lack of human intervention should be the default. Within this context, the recently developed Resist-Accept-Direct (RAD) framework (Lynch *et al*. 2021; Schuurman *et al*. 2022) is a valuable tool for making informed, purposeful choices about how to respond to post-fire vegetation transitions, expanding the decision space beyond the tendency to always resist such transitions (eg Guiterman *et al*. 2022). However, considerable uncertainty remains around the potential outcomes, feasibility, and implications of deciding to accept or direct vegetation transitions (Jackson 2021; Crausbay *et al*. 2022). Research on ways to address these uncertainties would increase flexibility in defining acceptable post-fire outcomes and support managers who move beyond management paradigms based on maintaining or restoring conditions from the recent past. For example, co-developing research with Tribal communities that have used cultural burning and other practices to direct vegetation change for thousands of years could support decisions to direct post-fire vegetation transitions. Many existing management actions (eg fuel reduction treatments, post-fire planting) could be employed to manage post-fire vegetation transitions within the RAD context; however, research co-produced with managers is needed to define which existing strategies could be used in new situations or to promote different goals, such as directing change to different species composition or forest structure. Finally, understanding the implications of accepting post-fire vegetation transitions for important ecological and cultural resources in different ecosystems could inform collaborative decision-making processes about where to resist, accept, or direct transitions (Crausbay *et al.* 2022).

The effectiveness of actions taken to manage post-fire vegetation transitions varies depending on where or when action is taken. As land managers face an increase in post-fire landscapes, it is critical to develop a better understanding of which strategies will be most effective under specific conditions. This may involve actions such as synthesizing existing studies, developing regional collaborations that enable replicate experiments across biophysical gradients (eg McIver and Brunson 2014), and collaborating with members of Tribal communities who hold extensive place-based knowledge (eg Wynecoop *et al.* 2019) and natural resource managers who observe the results of management actions in their local context (Glenn *et al.* 2022). The recent increase in area burned at high severity (Parks and Abatzoglou 2020), which is particularly vulnerable to vegetation transitions, also presents an opportunity for researchers and managers to collaboratively leverage post-fire treatments within an experimental context to better evaluate effectiveness of emerging management strategies, such as assisted gene flow or migration, new reforestation practices, or prescribed fire in recently burned areas (eg Panel 1; North *et al.* 2019; Stevens *et al.* 2021). As strategies for managing post-fire vegetation transitions are researched, it will be critical to consider how "effectiveness" and "success" are defined and to establish consistent methods of evaluation that incorporate an array of ecosystem responses and processes, including impacts of management on ecocultural resources (Marks-Block *et al.* 2019).

Current science to support management of post-fire vegetation transitions is often shared through online tools or databases (see Appendix S1: Table S1). However, guidance on which tools to use at specific times and locations is largely lacking (but see Vano and Lukas [2022]), and there has been little evaluation of the effectiveness of these tools for planning intervention strategies and achieving desired management outcomes. Many researchers are working to make relevant science publicly accessible through online applications, but substantial need remains for such tools to be co-produced with intended end-users to ensure that the tools are useful to decision makers (eg Krosby *et al.* 2018).

Relatedly, although there are increasing calls for "co-production" with resource managers and collaboration with Tribes to create management-oriented science (eg Beier *et al.* 2017; Wong *et al.* 2020), barriers—including existing organizational cultures, lack of incentives for scientists, and inadequate funding for applied science—remain, which limit widespread co-production (Glenn *et al.* 2022). Through its regional Climate Adaptation Science Centers, the US Geological Survey is one example of a funding agency that successfully emphasizes management-oriented science by evaluating proposals equally on their engagement with stakeholders and their scientific merit (DeCrappeo *et al.* 2018). An increase in funding sources that emphasize Tribal and non-Tribal stakeholder engagement from the proposal-writing stage through project completion, rather than outreach at the end of a project, would allow researchers to focus more explicitly on building relationships with Tribal and non-Tribal management communities (DeCrappeo *et al.* 2018; Wong *et al.* 2020). There is also a need within research institutions to better reward and value applied research and outreach (Rozance *et al.* 2020; Glenn *et al.* 2022). Although many early-career scientists may be interested in collaboratively producing research with local management or Tribal communities, they are often constrained by not having the necessary collaborative research skills and appropriate career incentive structures (Rozance *et al.* 2020). Furthermore, managers and communities may be limited in their capacity to engage with researchers.

Supporting adaptive management through improved monitoring and coordination

Managing landscapes that are undergoing or may experience future vegetation transitions challenges current management approaches and decision-making contexts (Schurmann *et al.* 2022). The goals and objectives of managing post-fire vegetation transitions will vary greatly depending on the ecological and social context that determines where it is feasible and socially acceptable to resist, accept, or direct transitions (Higuera *et al.* 2019; Schuurman *et al.* 2022). In a time of rapid change, management approaches will need to be flexible and adaptive to a range of potential future vegetation, fire, and climate scenarios. Effective adaptive management of post-fire systems will thus require coordinated monitoring of vegetation transitions across both space and time, understanding the human dimensions of vegetation transition management, and evaluating management effectiveness in regard to desired ecological and social outcomes (Lynch *et al.* 2022).

Across a range of ecosystems in the US West, vegetation transitions are a concern among managers (Guiterman *et al.* 2022), yet they can be challenging to identify or respond to. While in some systems (eg dry, low-elevation forests and sagebrush) transitions are well documented, in other systems transitions are potentially just emerging, and in still other systems the likelihood of future transitions is not well understood. Long-term, landscape-scale monitoring can help identify transitions as they occur; this will require coordination among management entities to ensure learning occurs across relevant ecological scales and is not limited by jurisdictional boundaries. Furthermore, incorporating different forms of knowledge into monitoring efforts would expand their temporal and spatial scope. For example, community-based monitoring involves tracking signs of environmental change based on a given group's ways of knowing (Johnson *et al*. 2016) and these observations can be contributed to community-based observing networks to monitor dispersed geographic locations with high-quality local information (Alessa *et al*. 2016). Considering TK, dendroecology, and paleoecology could also provide a longer-term perspective on post-fire vegetation transitions (eg Crausbay *et al*. 2017), while leveraging remote-sensing data could expand the spatial scale of post-fire monitoring (eg Wickham *et al*. 2023).

Leveraging, coordinating, and expanding existing monitoring networks will be key to evaluating the outcomes of different management actions aimed at addressing post-fire vegetation transitions. For example, long-term monitoring studies focused on forest adaptation in response to changing climate and fire regimes have provided valuable learning opportunities (eg Adaptive Silviculture for Climate Change Network [https://www.adaptivesilviculture.org], Long-term Ecological Assessment and Restoration Network [https://eri.nau.edu/research-topic/long-term-ecological-assessment-and-restoration-network-learn]). Investments in monitoring are also made through programs like the Collaborative Forest Landscape Restoration Program (CFLRP; McIntyre and Schultz 2020) and the US National Park Service's fire effects monitoring program (https://www.nps.gov/orgs/1965/fire-effects-monitoring.htm). However, creating systems and capacity for collecting, storing, and sharing relevant monitoring data across these diverse projects, geographies, and agencies would improve the ability to understand how and why management outcomes vary over space and time (Wurtzebach *et al*. 2019). In addition, platforms that link manager observations with information from existing monitoring networks have the potential to elevate local management perspectives and improve knowledge of the extent of transitions and effectiveness of management efforts. Documenting and sharing both the "failures" and "successes" of management efforts (eg replanting) is important in building robust monitoring data. When collected after fires, monitoring data are often unanalyzed due to capacity constraints; therefore, resources to assess historical data and track outcomes are also needed.

Monitoring and evaluation requirements are not restricted to ecological responses. More information is needed to understand the human dimensions of vegetation transitions to localize and integrate new post-fire management guidelines (eg Meyer *et al*. 2021; Stevens *et al*. 2021; Larson *et al*. 2022) into planning and management spaces (Clifford *et al*. 2022). Collaborative efforts and assessment of community and Tribal priorities and concerns are important for shaping management goals, understanding feedbacks between social and ecological systems, and building acceptance of necessary interventions. For example, culturally appropriate pre- and post-fire treatments can be designed if Tribal values and priorities are elevated when identifying management goals (eg Panel 1; Western Klamath Restoration Partnership CFLRP proposal [https://www.fs.usda.gov/restoration/documents/cflrp/2019Proposals/R5_WesternKlamath_CompleteProposal_NewProject.pdf]). Vegetation transitions can result in a perceived loss of place and emotional distress, which can influence local community attitudes toward post-fire management (Waks *et al*. 2019). Community acceptance of climate-adapted revegetation and other management actions after a wildfire can be increased through local educational efforts such as field trips, community collaboration, and incorporation of community values, which can build a shared understanding of problems and solutions (Olsen and Shindler 2010; Waks *et al*. 2019; Yung *et al*. 2022). For example, participatory planning processes that engage scientists, managers, Tribal members, and community members could be employed to make collective decisions about where and how to resist, accept, or direct vegetation change (eg Clifford *et al*. 2020; Lynch *et al*. 2022). Finally, monitoring socioecological indicators (Rossier and Tripp 2019a) can improve understanding of how management actions and vegetation transitions impact plants and animals that have strong ties to human communities (Rossier and Tripp 2019b).

Conclusions

Addressing the environmental challenges posed by climate change requires transformative changes in how we relate to and manage ecosystems (Díaz *et al*. 2019). The effectiveness of efforts to manage post-fire vegetation transitions, which alter not only ecosystems but also the myriad services they provide communities, will ultimately be a function of what is both biophysically and socially possible and will require strengthening socioecological connections to support cross-jurisdictional management efforts and partnerships that center Indigenous communities. Collaborative groups, such as the Western Klamath Restoration Partnership (Figure 3) and the East Jemez Landscapes Futures Collaborative (Panel 1), highlight how applied research and monitoring, improved inter-jurisdictional coordination and knowledge-sharing, and centering Indigenous communities in collaborative management of fire-prone landscapes can help promote the necessary changes to existing management regimes. Expanding such collaborative, boundary-spanning efforts to integrate and apply these key components across landscapes will be critical for managing post-fire vegetation transitions ethically and effectively as they increasingly impact landscapes across the US West and beyond.

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No data or code were produced for this manuscript.

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