Using mental models to understand trade-offs in wildfire risk mitigation

Issue

Throughout much of the Pacific Northwest, the interplay between environmental and social change not only contributes to wildfire risk, but also complicates efforts to mitigate it. As fire-prone landscapes become increasingly economically and culturally diverse, wildfire risk mitigation decisions have implications for a correspondingly broader set of values, resulting in greater potential for trade-offs (that is, actions that enhance some values but adversely affect others).

At the same time, trade-offs can be obscured by complex interactions among physical, biological, social, political, and economic processes that operate across multiple spatial and temporal scales. For example, aggressive response to wildfires in remote regions may prevent them from spreading to populated areas and thereby reduce risk to homes, but may do so at the expense of ecological values in wilderness areas. Thinning dense vegetation can benefit timber-based economies while reducing hazardous fuel loads but may reduce habitat for species such as the northern spotted owl and is considered cost-prohibitive at large scales. Navigating these types of trade-offs is a necessary and challenging task for land managers and other stakeholders working to address wildfire risk.

Research

We interviewed 111 wildfire risk stakeholders in the Eastern Cascades Ecoregion of Central Oregon. Stakeholders included private residents and landowners (e.g., woodlot owners, ranchers), as well as representatives of non-governmental organizations, fire departments, and different types of government agencies (city, state, federal, and tribal). The major focus of each meeting was a mental modeling exercise in which individuals identified factors related to wildfire risk as well as how they considered those factors to affect one another (Figure 1). We classified all factors, and focused especially on factors classified as *actions* (e.g., use of prescribed fire) and *outcomes* (e.g., improved firefighter safety).

A key advantage of mental models is that we could analyze how stakeholders perceived actions to affect multiple outcomes, often indirectly (i.e., via intermediary factors). This

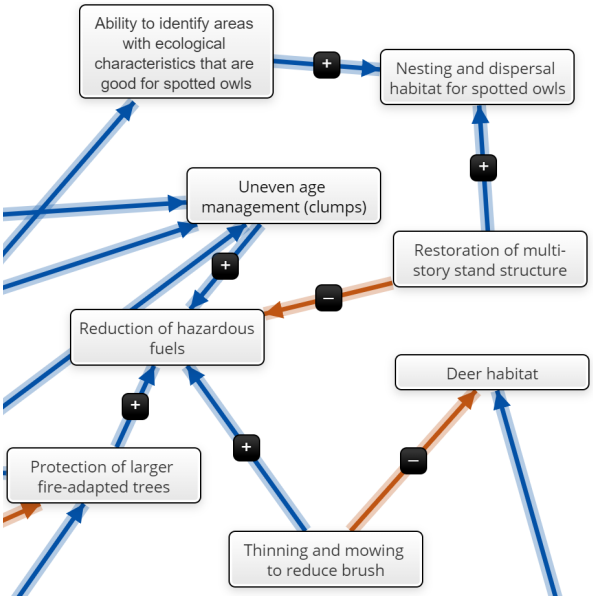

Figure 1: Section of a mental model, as depicted in MentalModeler (www.mentalmodeler.org), featuring two trade-offs: “Restoration of multi-story stand structure” has a positive effect on “Nesting and dispersal habitat for spotted owls”, but a negative effect on “Reduction of hazardous fuels”. Likewise, “Thinning and mowing to reduce brush” negatively affect “Deer habitat” but positively affect “Reduction of hazardous fuels”.

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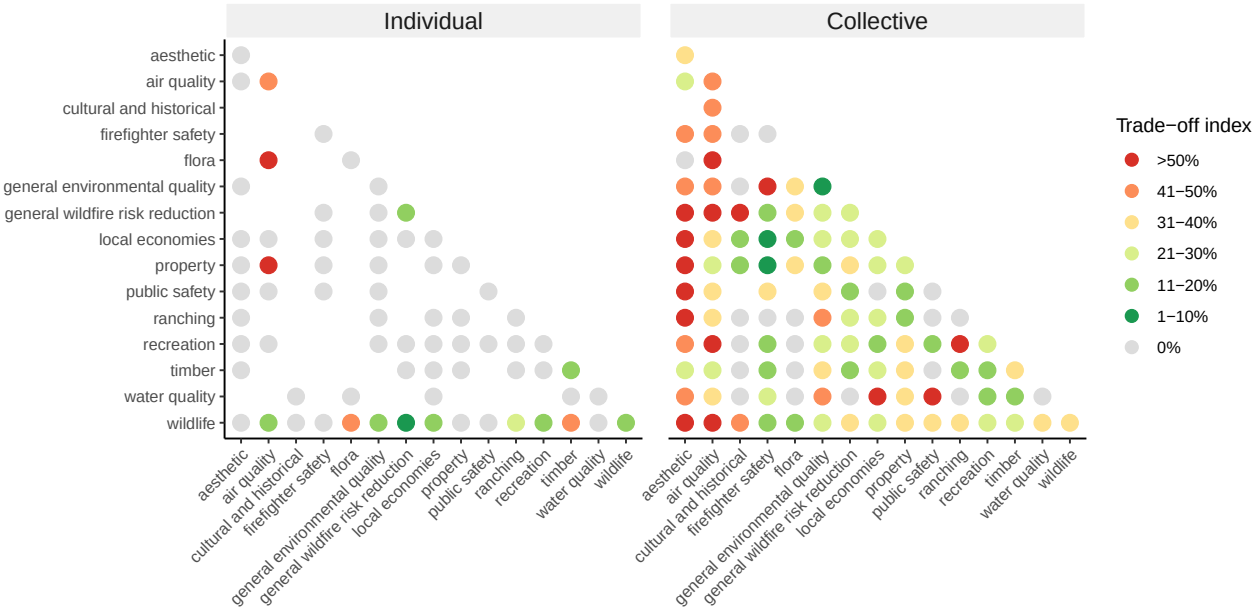

Figure 2: Degree to which actions result in trade-offs between those outcomes of different values categories. The trade-off index measures the proportion of potential trade-offs that are trade-offs.

allowed us to analyze perceived trade-offs, which we measured as instances in which an action affected one outcome positively and another outcome negatively. By comparing stakeholders' individual mental models to a "collective" mental model (the aggregation of all individual mental models) we were also able to analyze how perceptions of trade-offs changed when we accounted different perspectives on fire risk from diverse stakeholders.

Key Findings

Individual mental models feature three general groupings of trade-offs (Figure 2). The first group involves wildlife. Outcomes within this value category were featured in trade-offs with outcomes in 8 of the 14 other categories of values. Another group involves air quality. Compared with outcomes related to wildlife, air quality outcomes were featured in trade-offs with fewer other value categories. However, air quality was involved in high incidences (>50%) of trade-offs with outcomes in two such categories–flora and property. The third group involved trade-offs between outcomes of the same value category. Individuals conceptualized trade-offs between pairs of air quality, general wildfire risk reduction, timber, and wildlife outcomes.

While categories of values varied in their tendencies to be associated with trade-offs, we likewise found variance in the degree to which different types of actions prompted trade-offs, which additionally varied between the individual and collective mental models (Figure 3). For individual mental models, actions that involved wildfire response were associated with the lowest proportion of trade-offs, followed by legal actions, then forest management actions, and finally by actions related to outreach and education efforts. By contrast, in the collective mental model, wildfire response actions were most prone to trade-offs, followed by forest management, outreach and education, and finally legal actions.

Management Implications

Taken together, these results have important implications for wildfire risk mitigation in the Eastern Cascades Ecoregion, as well as in other socially complex wildfire-prone landscapes. In

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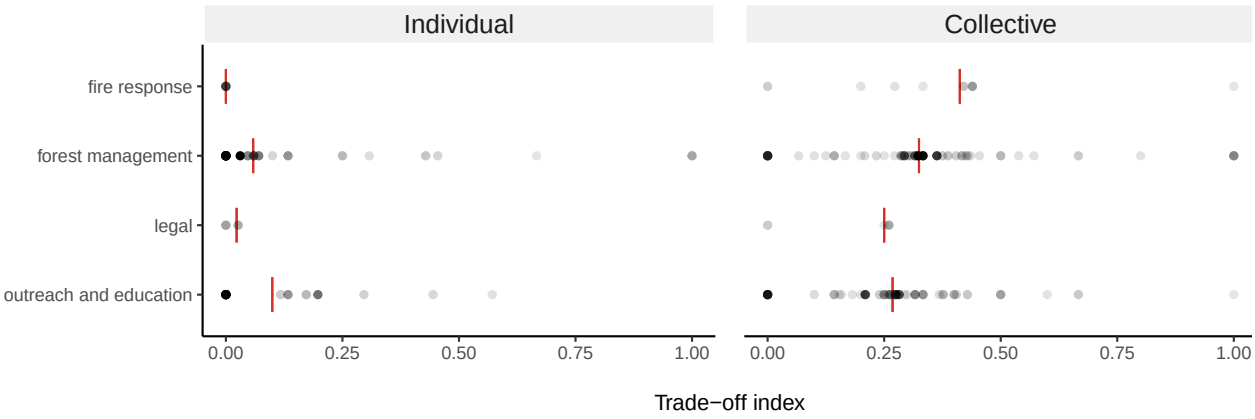

Figure 3: Tendency for actions to result in perceived trade-offs. The trade-off index measures the mean of trade-offs, such that 1=always trade-offs and 0=never trade-offs. Points represent actions (e.g., "forest thinning") and are shaded according to the number of times they are featured in potential trade-offs.

particular, our analysis of the types of outcomes involved in trade-offs highlights a gap between independent and collective cognition of wildfire risk. The dominance of trade-offs related to wildlife in individual mental models points to the need for greater awareness of the variety of ways in which management affects habitat for different species. However, when individual mental models are aggregated into a collective mental model, the primacy of wildlife-related trade-offs gives way to trade-offs that involve aesthetic value and air quality. Advocates of risk reduction actions that have outcomes on aesthetic values (e.g., most forest management practices) should be attentive to variation in aesthetic preferences across socially diverse landscapes. The high proportion of trade-offs involving air quality provide empirical support for what many decision-makers and other wildfire risk mitigation practitioners know from personal experience–stakeholders may not distinguish "bad" smoke (e.g., from large-scale wildfires) from "good" smoke (e.g., from prescribed fires that serve to reduce hazardous fuel loads). To the extent that management actions necessary for mitigating wildfire risk also unavoidably generate smoke, our results highlight the importance of outreach and education that forthrightly addresses smoke impacts in the broader context of wildfire risk reduction.

Finally, our study highlights the importance of initiatives that encourage collaborative decision-making. In the Eastern Cascades Ecoregion, groups such as the Deschutes Collaborative Forest Project, the Klamath Lake Forest Health Partnership, and Project Wildfire bring together diverse stakeholders to facilitate wildfire risk mitigation planning and decision-making. Such settings provide opportunities for stakeholders to expand their own mental models of wildfire risk while presenting their understanding of how actions shape outcomes in ways that may not be appreciated by other stakeholders. Our results suggest that individuals independently tend to conceptualize action-outcome "paths" that only become trade-offs when combined with other individual mental models. Wildfire risk mitigation planning processes that bring together diverse groups of individuals provide a mechanism for combining these paths in a group-based mental model that can facilitate decision-making.

For more information

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