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Setting the Land Ablaze: Rancher Perceptions and Experience with Wildfire May Not be a Deterrent to Prescribed Burning on U.S. Central Rocky Mountain Rangelands

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Abstract
Fire is an inherent disturbance in western North American ecosystems, but wildfire mitigation and prescribed fire application is complicated by human social perspectives and behaviors. Given the variability of rancher use of fire within and across regions of the United States, we interviewed thirty-three ranchers in U.S. Central Rocky Mountain (CRM; Montana, Wyoming, Colorado) rangelands to understand how wildfire experiences and perceptions are related with rancher willingness to utilize prescribed fire. Results indicate rancher willingness to utilize prescribed fire in rangeland ecosystems may not be explained by rancher perceptions and experience with wildfire. Specifically, CRM rancher willingness to utilize prescribed fire may not be constrained by wildfire experiences [which was statistically similar between burner (n = 12) and non-burner (n = 21) orientations; all p-values > 0.05] regardless of wildfire proximity (on the ranch or nearby) and may be enhanced by their perceived benefits of wildfires.

Key words: Wildfire, Prescribed fire, Central Rocky Mountains

Running Title: Rangeland Ranchers' Use of Fire

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Introduction

The narrative between fire and humans has been interwoven since the beginning of human expansion across diverse landscapes (Pyne 2019). As people continue to occupy new areas and with anticipated changing climate, forest and rangeland ecosystems will continue to face wildfire challenges (Donovan et al. 2017; Jones et al. 2022; Li et al. 2022). Conversely, prescribed fire is being reestablished in western North American ecosystems by land managers to meet multiple management objectives. Maintaining and reestablishing prescribed fire in rangeland, grassland, and forest ecosystems yields known beneficial dividends for biotic and abiotic factors such as vegetation, hazardous fuels reduction, and a reduction in woody brush encroachment, but wildfire experiences and perceptions may overshadow private landowners' willingness to utilize prescribed fire (Fernandes & Botelho 2003; McGranahan et al. 2012; Twidwell et al. 2016).

Escalating wildfire suppression costs and impacts across forest and rangeland ecosystems, suggesting an urgent need for private landowners and managers to reconsider current management objectives and ideologies (Abt et al. 2009; Hope et al. 2016). Prescribed fire is one of the primary strategies to reduce the scale and impact of catastrophic wildfires by reducing fuel loads, but also presents potential risk of escape (Fernandes & Botelho 2003; Kolden 2019). However, regardless of the ratio of successful prescribed burns, even a single escaped prescribed burn could and has led to a wildfire, conflating that all fire is "bad fire" (Weir et al. 2019; Wilbur and Scasta 2021). Finding creative strategies to engage the public to reevaluate the application of prescribed fire will create more efficient and effective fire management to address hazardous fuels particularly in areas like the Rocky Mountains of North America (Toman et al. 2006; Crow et al. 2015; Kolden 2019).

While increasing research on quantifying the social attitudes, perspectives, and application of prescribed fire as a land management tool and a wildfire mitigation strategy, there is a paucity of research about the relationship between wildfire experiences and prescribed fire use (Clark et al. 2022; Cowan et al. 2023). This study is a subset of data from a larger project that researched ranching communities ecological and social dynamics for utilizing prescribed fire. Here, our goal was to understand how experiences and perceptions with wildfires affect ranching communities' willingness to utilize prescribed fire in the U.S. Central Rocky Mountain states of Montana, Wyoming, and Colorado – an area with a heterogeneous fire culture.

Methodology

We interviewed thirty-three participants across U.S. Central Rocky Mountain (CRM) states of Montana, Wyoming, and Colorado, USA (Figure 1). We worked with agricultural nonprofits, extension offices, federal agencies, and personal contacts to gather our initial subset of participants. Then, we used a purposive snowball sampling approach asking participants to suggest other ranchers who might be willing to participate in our study (Merriman and Tisdell 2016). The requirements to participate were that the rancher must be part of the decision-making process and be willing to share management choices. We continued to interview rancher participants until saturation (Morse et al. 2008). We used semi-structured interviews which included open-ended discussion questions that covered ecological and social factors impacting rancher management decisions, and

the capacity to use prescribed burning as a management tool[4]. The rancher participation representation in this study may not completely embody views throughout CRM. Although, the study does present an initial starting point for examining regional narratives which remain unexplored when compared to other areas, such as the U.S. Great Plains (Twidwell et al. 2013; Bendel et al. 2020; Hoffman et al. 2021; Adhikari et al. 2023). Furthermore, we were purposeful in our attempt to encompass the entirety of each state, but the lack of resources, time, and network limited our capacity to reach a broader audience as did the coronavirus (COVID-19) pandemic.

We conducted 32 interviews over the phone and 1 over zoom (n = 33) in 2020-2021. The interviews ranged from 45 minutes to 3 hours. Ranching communities vary ecologically and culturally so we used a grounded theory approach that uses flexible and systematic strategies to construct a theoretical understanding of qualitative data (Charmaz 2014; Merriam and Tisdell 2016). Verification of the research findings were enhanced through validation of transcripts sent to each participant once the primary author had transcribed the interview (Merriman and Tisdell 2016). We developed an initial list of potential themes based on the research questions and ranch management from previous social fire research but added additional themes and codes as they emerged (Kreuter et al. 2008; Toledo et al. 2013; Joshi et al. 2019). We conducted a line-by-line, open-coding review of each interview to validate thematic coding initially created and included additional themes if they emerged. Analysis incorporated both qualitative and quantitative analysis of prescribed fire orientation and wildfire.

For the quantitative analysis, we first stratified ranchers by their use of prescribed fire as those that used prescribed fire and those that did not (Figure 1). A prescribed burner ('Burner') was defined as a rancher that has used fire to broadcast burn, ditch burn, or pile burn to meet management objectives. Then, we tallied the number of codes each rancher articulated in the interview into a dichotomous yes (1) or no (0) on their experience (wildfire on their land or on nearby properties) and perception (prescribed fire may mitigate wildfire, their ranch is susceptible to wildfire, wildfire may have benefits, wildfire may have negative consequences). Next, we conducted a logistic regression with each perception and experience as the dependent variables and burner orientation as the predicting variable (Figure 2, Table 1). Results should be interpreted with caution because the interviews were semi-structured to allow for exploration about fire, and ranchers may have considered some of the codes created but had not articulated them during the interview session. For our qualitative assessment, we examined the context of the tallied codes for ranchers to understand the nuanced complexity and consensus between the burner orientation and wildfire.

Results and Discussion

Ranchers encompassed a diversity of prescribed burning orientation with 21 ranchers who did not conduct prescribed burns ('Non-Burner') and 12 ranchers who currently, or have historically, conducted prescribed burning as a management tool ('Burner'; Figure 1, Table 1). Four ranchers had historically used prescribed burning but did not plan to use it in the future. Across the 3 states, there was variability of burner orientations, and no state was dominated by one or the other (Figure 1).

[4] Specific participant names and study locations were omitted from the results to ensure participant confidentiality. Human subjects research was approved through the University of Wyoming – Institutional Review Board (IRB) protocol #20200221RW02680.

Most of the ranchers interviewed had experienced a wildfire on their ranch or were aware of a wildfire nearby (91%). However, a rancher experiencing a wildfire ('WFRanch') on their property, or a wildfire nearby ('WFnearby') did not dictate the use of prescribed fire as a management tool (both *p*-values > 0.05; Table 1, Figure 2). Burners experienced a wildfire on their ranch and discussed wildfires nearby proportionally and statistically similarly to non-burners (Table 1, Figure 2). Furthermore, burners expressed the benefits of wildfire (67%) more than the consequences (50%) as one ranch manager discussed:

> *"The long-term benefit couldn't have been a better treatment for that ranch, it burned through a part of the ranch that was all canyons and interconnected canyons and in some places 100% pinion juniper encroachment in the upper end of those canyons and it cleaned it out. So, in a year or two, depending on precipitation, [it's] going to be a new ranch, this was hard, it was just hard in a year where grass is short that we lost that much of it." (CRM05)*

Given enough time after a wildfire, burners find wildfires to be beneficial to their livestock operation by reducing shrubs and trees. Moreover, all the burners discussed goals of using prescribed fire to reduce shrubs and trees such as "juniper encroachment." Overcoming the short-term forage loss and uncertainty of timely regrowth may stymie hesitant non-burners' perception and experience of wildfire benefits (see below).

Non-burners also perceive themselves to be as susceptible to wildfires (43%) as burners (25%) ($p = 0.298$; Table 1, Figure 2). As one rancher expressed: "I would say that we are pretty susceptible to it... So it is a concern, there's, there's quite a bit of fire in our area" (CRM 17). Furthermore, non-burners (n = 21) articulated the consequences of a wildfire (57%) more than the potential benefits (38%) (Table 1, Figure 2). For example, one non-burner discussed "we lost half of our grazing resource, April 1st in the prairie fire. We don't really know what our contingency plan is" (CRM06). Furthermore, adjusting to a wildfire on a ranch can be detrimental to some ranching operations like one non-burner mentions:

> *"So we grazed the back over some country that we had used. And we, we made it, probably to the detriment of the pasture part, possibly. The remaining pasture here, so we did. We did keep the herd together and we didn't feed them or anything like that, we did sell the calves and early. Took the calves off for like the first October. To get them off, get them out of there. But that did hurt us." (CRM 21)*

While there are devastating impacts as the result of wildfires, some non-burners see the value of wildfires (38%) (Table 1, Figure 2). One mentions, "… we have had a fire, a huge fire in the canyons. And everybody was like, let it burn, let it burn, let it burn those cedars, because that really is the best control…the next year or two, the grass comes back phenomenal" (CRM07).

The capacity to withstand wildfire impacts through alternative forage resources or wildfire mitigation strategies is an important consideration to implement into livestock operations. Otherwise, ranchers may face decreases in economic and livestock production. Only four non-burners (19%) mentioned taking actions to mitigate wildfires (Table 1, Figure 2). Ranchers who did mention mitigation efforts prefer livestock grazing as the form of mitigation, as two ranchers mentioned, "my opinion is if I had my preference for tools, I would rather use controlled grazing to push the vegetation in the direction I'd like to see it go rather than using controlled burning" (CRM 19) and

"[i]f you manage your grass right, you're going to have greener plants. And if you do have a fire, it's not going to be a devastating thing that just rips through the country" (CRM29). Ranchers mitigate wildfires through grazing management because it also benefits them for livestock production, but prescribed fire has been shown to be the most effective tool to mitigating wildfire (Fernandes & Botelho 2003; Kolden 2019). Only one non-burner (5%), and no burners (0%) discussed perceived benefits of utilizing prescribed fire to mitigate wildfires (Table 1, Figure 2).

Our research demonstrates the complexity of rancher willingness to utilize prescribed fire in rangeland ecosystem goes beyond experiences with wildfires and that not all fire is considered to be bad. The presence of wildfires nearby or on the ranch is not a significant indicator of a rancher's willingness to conduct prescribed burns as a management tool. While wildfires can be devasting in some contexts, burners discussed more benefits associated with a wildfire than the consequences as one rancher mentioned, "we've had one major fire … and did us a world of good" (CRM 33) (Figure 2, Table 1).

We did not find a strong connection between wildfire and prescribed burners, but we constrained our research to only wildfire experience and perceptions, when other research has shown cultural norms, access to resources, and heuristics as important indicators of ranchers' willingness to utilize prescribed fire (Toledo et al 2013; Hoffman et al. 2021). Future research should further explore wildfire experiences and social dynamics (e.g., perceived risk and benefits of prescribed fire) to uncover more of the relationship between ranchers and fire. This research was one of the first attempts to incorporate wildfire perceptions and experiences into ranchers' willingness to use prescribed fire in rangeland ecosystems.

Ranchers' capacity to flexibly manage by working with fire instead of working against it, may facilitate a more resilient landscape as we move into extreme climatic conditions and increasing catastrophic wildfires (Jones et al. 2022). Developing targeted educational strategies which combine ecological and social considerations will foster creative solutions that meet the needs of ranching communities while mitigating the potential devastating effects of wildfires. Our research shows, in the U.S. Central Rocky Mountain region, the experience and perceptions with wildfire, and a willingness to conduct prescribed burns is not linear and educational pathways need to adapt to the variability of interest to improve the tolerance of prescribed fire.

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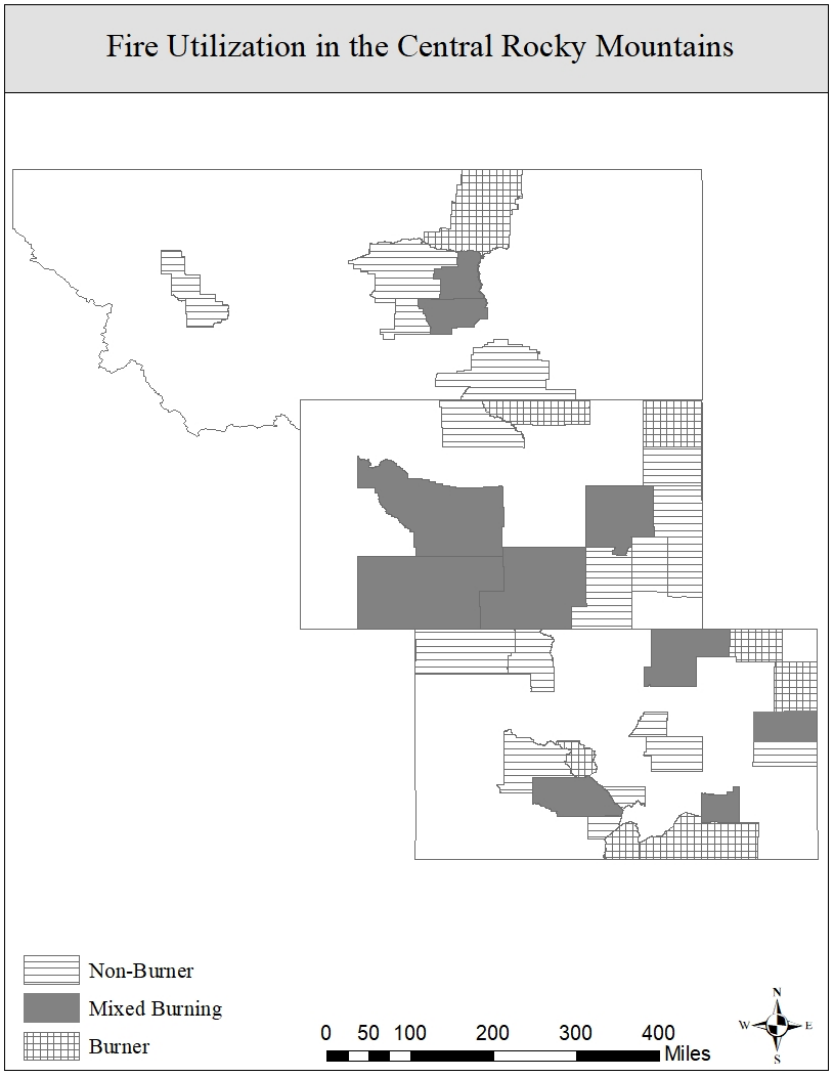

Figure 1. *Participant distribution by county and rancher burner orientations as an indication of willingness to burn where 'Non-Burner' indicates not currently using fire and 'Burner' indicates currently using fire. 'Mixed burning' indicates there were multiple participants interviewed in that county representing both non-burners and burners and is an indication of a diversity of rancher burner orientations.*

***Table 1**. Rancher Burner Orientation (Non-Burner or Burner) as a Binary Predictor of the Relationship with Rancher Perceptions and Experiences with Fire*

	Rancher Burner Orientation		Model Statistics[1]	
Rancher perceptions and experiences	***Non-Burner* (n = 21)**	***Burner* (n = 12)**	**$\chi 2$**	***p*-value**
Prescribed Fire to Mitigate Wildfire	5% (1 of 21)	0% (0 of 12)	0.922	0.337
Wildfire Susceptibility	43% (9 of 21)	25% (3 of 12)	1.084	0.298
Wildfire on Ranch	52% (11 of 21)	75% (9 of 12)	1.691	0.193
Wildfire Nearby	57% (12 of 21)	75% (9 of 12)	1.084	0.298
Benefits of Wildfire	38% (8 of 21)	67% (8 of 12)	2.531	0.112
Consequences of Wildfire	57% (12 of 21)	50% (6 of 12)	0.157	0.692

[1]*Logistic regression analysis with Rancher Burner Orientation (Non-Burner or Burner) as the main predictive factor and each rancher perception and experience as dependent variables.*

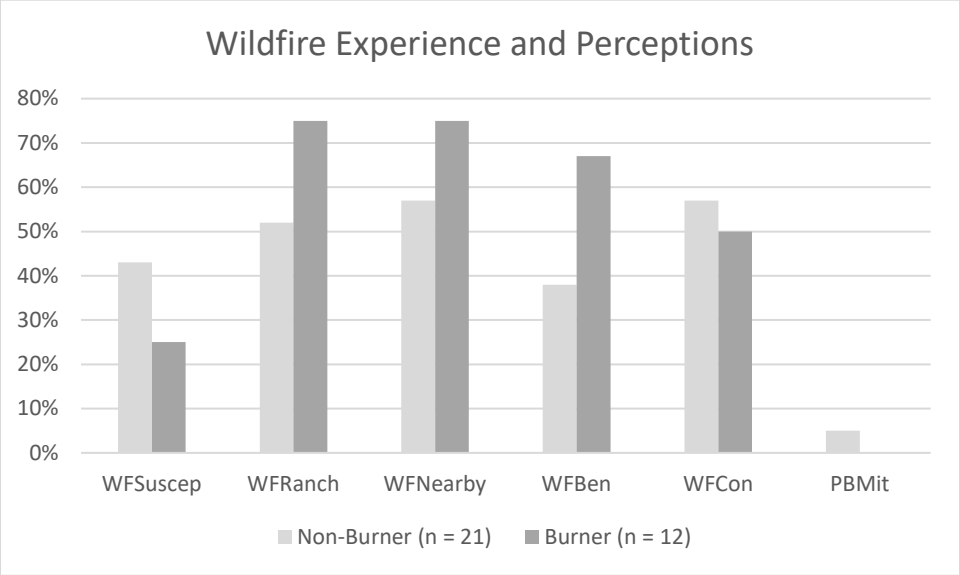

***Figure 2.** Summary of U.S. Central Rocky Mountain (CRM) Rancher Wildfire Experiences and Perceptions as it Relates to Whether they Utilize Prescribed Fire ('Burners') as a Management Tool or Not ('Non-Burner')*