# Leveraging Social Science Research to Advance Contemporary Rangeland Management: Understanding the "New Faces" of Range Managers

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# Leveraging social science research to advance contemporary rangeland management: Understanding the "new faces" of range managers

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## On the Ground

- Rangeland management research has historically focused on the ecological dimensions of these unique ecosystems, but the social dimensions of rangeland management have been understudied.
- Considering rangelands as complex socio-ecological systems, we offer a framework to provide insights into how increased engagement of social science research can improve the management of contemporary rangeland ecosystems.
- We posit the framework within shifting socio-demographic conditions experienced in contemporary rangeland systems, which include an increasing diversity in the socio-demographics of rangeland managers; an increasing number of younger ranchers inheriting or purchasing ranches from aging ranchers; and an increasing presence of exurban migrants moving from cities to rural areas.
- Within this context, our framework centers its attention on contemporary rangeland managers and discusses their relationship with different relevant social institutions and natural resources while offering insights on how social science research can facilitate a better understanding and more up-to-date information concerning these relationships.

**Keywords:** conceptual framework, human dimensions of rangeland operations, social sciences.

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## Introduction

Rangeland management is the art of applying science and experience to make decisions seeking to optimize economic and ecological health and resilience of rangeland resources.[1] Rangeland managers are highly motivated to maintain productivity and opportunistically obtain economic returns to help sustain the ranching operation without depleting or compromising the natural resource base.[2-4] Such goals have historically been predominantly supported by research studying the various biophysical elements of rangeland ecosystems.[5-7] That is, natural and ecological scientists have taken the lead in generating and disseminating recommendations for managing the natural resources of rangelands. Relatively recently, however, awareness of rangeland systems as integrated socio-ecological systems[5-7] has increased, resulting in an emergent need to better understand both the natural and the human dimensions of these systems.

Our focus in this paper is on the social aspects determining how people think and act in relation to managing the ecological dimensions of these socio-ecological systems, which we believe is critical. This is because, as noted by Barrow and Mumphree,[8] "By virtue of their locations and activities, people are critically placed to enhance or degrade the present and future status of natural resources." Accordingly, and in the context of rangeland management, interest has increased in leveraging social science research to help rangeland managers make decisions that can contribute to the economic and ecological sustainability of their operations. In other words, understanding the social dimensions of rangeland management is key, as humans ultimately determine whether rangelands are sustainably or unsustainably managed. Humans define the goals driving operations and implement the tasks necessary to reach such goals. While sound ecological knowledge plays a big role in making sustainable decisions, access to such

knowledge does not guarantee that it will be applied effectively, or at all. The goal of social science research in rangeland management, therefore, should be to understand the many interrelated factors informing the decisions and behaviors of rangeland managers, including those factors stemming from academic and managers' inquiry.

More specifically, social science research can elucidate relationships existing between a problem, and the actions people take to address this problem within the context of social, ecological, and socio-ecological systems. We know such systems are complex, multiscaled, spatiotemporally variable, and constantly informed by multiple actors, policies, institutions, and information.[2,9] Thus, social sciences and its research can help disentangle some of those complex relations using theories and methods (see Bennett et al.,[10] for a detailed summary of social science fields, methods, and approaches) developed and used through decades focusing on capturing/measuring ways humans individually and/or collectively think about, value, and act in relation to a specific problem within such systems. Such theories and methods have focused on studying social phenomena, social processes, and individual attributes[10] to understand, describe, theorize, deconstruct, predict, imagine, or plan.[10] Methods used in social science research related to natural resources and conservation include qualitative (e.g., interviews, focus groups, ethnographies, and textual analysis), quantitative (e.g., surveys, economic valuations, modeling, and experiments), participatory (e.g., community-based research, participatory action research, and art-based methods), planning and forward thinking (e.g., visioning, scenario planning, and structured-decision making), evaluative (e.g., monitoring and evaluation, policy analysis, case analysis, and statutory interpretation), spatial (e.g., geographic information systems, historical geographic information systems, transect walks, and community-based mapping), historical (e.g., archival research, landscape histories, and oral histories), meta-analytical (e.g., meta-analysis, systematic reviews, and qualitative comparison analysis),[10] and mixed methods (e.g., combinations of the above).

Despite the relevance of social science research denoted above, its involvement in rangeland management is still limited.[5-7,11] Bruno et al.[6] indicated, "there is an opportunity to fully integrate and centrally locate the social sciences into the more holistic study of rangelands as complex social and ecological landscapes." This is not to say rangeland research has completely ignored social science. Effective extension programs lean heavily on social science research to improve outreach activities, and several peer-reviewed journals focus on publishing such research. In the United States, a broader, more complete integration of social science into the study of rangeland systems is, however, perhaps more important now than ever given the rapid social and environmental changes occurring within rangelands. Social changes include increasing diversity in the socio-demographics of rangeland managers,[6,7,12] increasing the number of younger ranchers inheriting or purchasing ranches from aging ranchers,[12] and an increasing migration of exurbanites to rural areas.[13,14] As a result, in the United States, rangelands are situated in a shifting socio-ecological environment characterized by different and diverse social actors that are critically engaged in the management of changing rangelands.

While our emphasis here is on the social dimensions of rangelands, it is important to recognize that such dimensions are reciprocally interconnected with and affecting/being affected by environmental changes currently experienced in rangelands. Such environmental changes include increasing prevalence and severity of heat waves and accompanying drought, altered biogeochemical cycles, and biological invasions by invasive species.[15] Within this context, our conceptual paper seeks to highlight the roles social science research can play in the study of contemporary rangeland management. We do this centered around the rangeland managers and their relationship with social institutions and natural resources. Here, we define rangeland managers as the person overseeing rangelands responsible of implementing management practices. This includes land managers from public or private sectors because we relate "rangeland managers" to the action people make to implement, or not implement, a management practice on a given piece of ground. In private lands, this would be the landowner/manager/designee/lessee. In public lands states, it could be the BLM or Forest Service representative in coordination with the allotment holder. Additionally, social institutions are defined as the diverse social actors relevant to rangeland management and the rules and norms shaping their interactions with each other (see Agrawal & Gibson[16]).

Overall, our goal in this article is to bring to light how social science research can facilitate the development and implementation of rangeland management practices pertinent to current social actors and realities. To do this, we first briefly describe socio-demographic trends currently shifting the human "faces" of rangeland systems. Then, we propose a conceptual model emphasizing the role of research related to the social dimensions of rangeland management, which we later discuss in the context of the understudied and shifting demographics described above.

## The new faces of rangeland managers

### Diverse understudied populations

In the United States, research on the socio-demographic characteristics of the actors managing rangelands has historically focused predominantly on ranchers, farmers, and landowners,[6] with adult white male ranchers being the most studied group.[6,7,11] This is largely due to the overwhelming dominance that 93% of producers are white men.[17] Research in this area has primarily focused on quantifying structural characteristics such as income, age, and education, and then correlating them to attitudes or practices, for instance the adoption of innovation and data-informed management behaviors.[6] However, very few studies of range management systems

have researched actors beyond adult white male ranchers.[6,7] Overlooked groups include youth, women, LGBTQ+ stakeholders, and ethnic minorities.[6] Addressing this knowledge gap is timely because across the United States, these understudied groups are growing in numbers and play increasingly important roles in managing rangelands. For instance, in Texas, the number and acreage of operations owned by African Americans, Hispanics, and women are steadily increasing.[12] The 2017 US Census of Agriculture reported >36% of contemporary American ranchers and farmers are women. While this, in part, reflects how the 2017 census changed the way it counted producers to be more inclusive of persons involved in agricultural production,[18] it should not discount the fact that more women are taking over these roles as a reflection of social, cultural, technological, and economic changes in society.[19] It is important to note that these understudied groups take highly variable roles in the management of rangeland and ranching operations.[20] It is, therefore, increasingly important to understand who they are, how they differ from the historically studied populations, and how their presence is impacting management decisions. As noted by Roche et al.,[4] such diversity and the current lack of understanding it, can be an important source of policy failure. Therefore, it is critical to assess these understudied populations as an integral part of the rangeland management system.

### Transfer of land and the new generation of rangeland managers

We know little about the rising generation of rangeland managers who are inheriting or buying land from the large base of aging baby boomer ranchers. These aging ranchers will soon start ceding ownership or management of their lands to their progeny or selling it to younger generations of ranchers. Such new actors may have different demographic characteristics than the previous generations upon which our understanding of the human dimensions of rangelands are built. Shifting demographics often translate to shifting values, norms, behaviors, and practices.[21] Related to this, the Natural Resources Institute[12] noted in the case of Texas:

> *Aging rural landowners in Texas will soon transfer working lands to younger generations and first-time landowners. The new landowners may have less experience or connection with the land, lack basic knowledge of agricultural operations and management, or lack the financial capital to maintain the land once inherited.*

Thus, it is critical to understand this new generation of managers and how their presence will impact land quality, the socio-political structure and function of rural communities, the ranches they will operate, and the implications of all the above for the economic and environmental conditions surrounding rangeland operations.

### Urban to rural migration

The composition of the population living in rural areas has been changing as a result of the desire and ability of city dwellers to move away from urban/suburban centers to rural areas rich in natural amenities. The amenity migration phenomenon in which city dwellers move seasonally or permanently to rural areas has been apparent in the United States since the 1970s and has received considerable attention within the social sciences.[22] Social and economic factors including transgenerational transfers of wealth, advancements in telecommunication and transportation, changes in working conditions, and increased availability of rural land as a result of their commodification for aesthetic/recreational value, have created increased opportunities for this urban to rural migration.[22-24] Recent evidence suggests the COVID-19 pandemic has accelerated this phenomenon,[14,25] though the duration of this and other sociodemographic trends associated with the pandemic remains unclear.

As a result of their presence and voices in their new rural communities, exurban migrants have considerable potential to reshape the socio-demographic fabric of rural America. As it relates to rangeland systems, this has implications for shifting and altering land uses and rangeland management practices. For instance, land fragmentation related to the burgeoning real estate market for supplying land to exurban dwellers directly and indirectly affects rangelands within and between adjacent properties. This increased juxtaposition of "old" and "new" landowners may lead to increased conflict, which in turn affects management decisions. In southern Idaho, ideas about how resources should be used to prevent and fight wildfire differed greatly between landowners in a recently developed residential area and landowners whose working rangeland abutted the residential development.[26]

The socio-demographic changes described above provide a critical challenge of understanding the composition of new rangeland managers and related actors in contemporary rangeland systems. Social science research can help uncover the specific demographics of these poorly understood actors, their attitudes and worldviews, land uses, economic and ecological practices, and other important aspects related to rangeland management. Social scientists are well positioned to assist in such tasks with respect to the new faces of land managers. Ways in which such tasks can be achieved by social science research are detailed in the following section.

## The role of social science research in understanding the new faces of range managers

To improve our understanding of the new faces of rangeland managers, we offer a conceptual framework to suggest how social science research can assist in producing valuable knowledge. Following Briske et al.'s[5] call to integrate social, political, and economic dimensions to inform rangeland management practices, the proposed conceptual

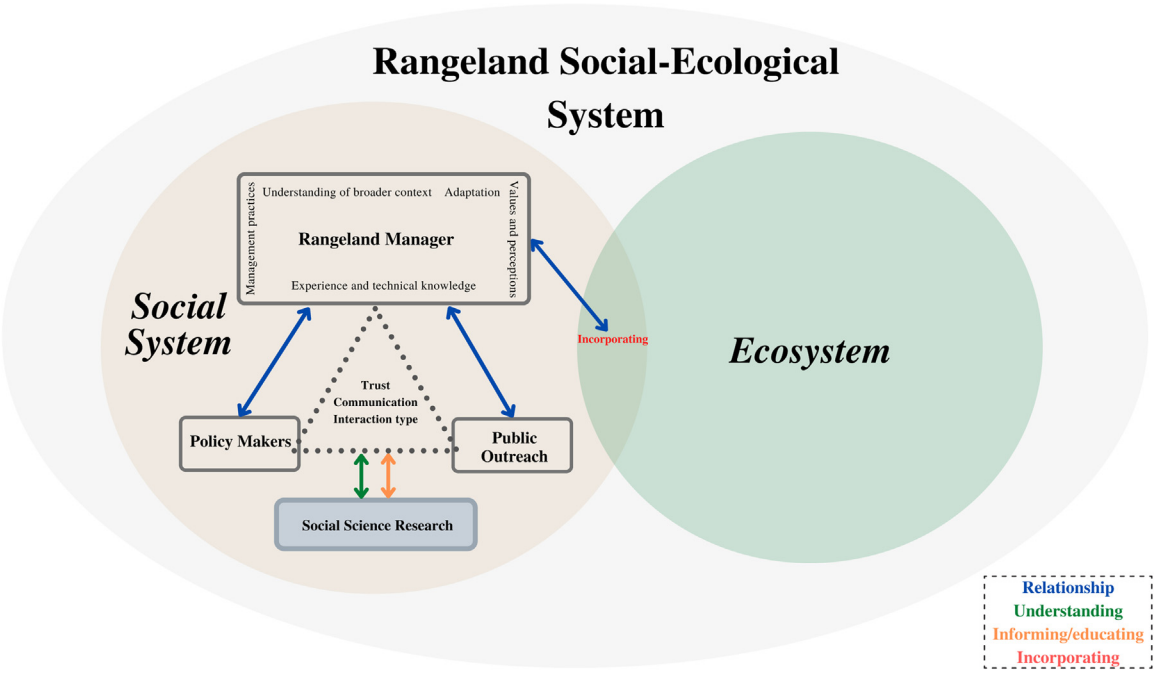


**Figure 1.** Conceptual diagram of how social science research can improve the relationships (through gaining understanding and informing) among rangeland managers, outreach agents, policy makers, and rangeland ecosystems. The relationship between rangeland managers and outreach agents and policy makers is mediated by trust, communication, and interaction. The relationship between the ecosystem and rangeland managers is influenced by their values and perceptions, their adaptability to changing circumstances, their understanding of the larger social, economic, and environmental context in which ranches operate, the experience and technical knowledge they have, and the management practices they engage in.

framework focuses on the role social science research can play in strengthening relationships (Fig. 1, blue arrows) among the socio-ecological institutions related to rangeland management. These include rangeland managers, outreach agents, policy makers, and rangeland ecosystems. Specifically, we emphasize the role of social science research in performing three general functions: 1) understanding (Fig. 1, green arrow), 2) informing (Fig. 1, orange arrow), and 3) incorporating (Fig. 1, red font). Understanding pertains to actions conducted by research that answer questions regarding structural (e.g., broader political, economic, environmental, and social conditions) and interactional (e.g., conditions associated with the interaction of different social actors) factors mediating relationships among rangeland managers, other human actors, and natural resources. Informing refers to the process of disseminating the knowledge produced by research intended to guide the rangeland manager and related social institutions with the objective of successfully reaching ecological and economic rangeland management goals. Incorporating refers to the extent that disseminated knowledge is assimilated and implemented by the human actors (i.e., stakeholders) in rangeland systems.

More specifically, as it pertains to relationships between rangeland managers and the rangeland ecosystem, social science research seeks to understand the factors informing the decisions managers make in relation to the natural resources being managed. Our framework includes rangeland managers' values and perceptions, their understanding of the broader context surrounding the ranch, their adaptation to change, their experience and technical knowledge, and the management practices they ultimately choose to employ.

However, the information social science research could produce within the above factors, by themselves do not guarantee adoption or successful implementation of desired rangeland management practices. This is because management decisions are highly influenced by knowledge and regulations provided by outreach activities and regulatory policies.[27] Thus, it is important to also understand and strengthen the relationship between rangeland managers and outreach and policy actors by producing information to help design strategies and management practices that optimize the economic and ecological health and resilience of rangeland resources.[1] Our framework includes factors such as trust, communication, and interaction types, which can influence the degree to which land managers ignore, reject, implement poorly, or accept, and execute stakeholder knowledge and legislated policy.[28-30] The following section offers a detailed discussion of the role of social science research in understanding the factors described above within the context of shifting sociodemographics of rangeland managers.

## Rangeland managers and ecosystem management

Following our framework, social factors influencing rangeland management include the values and perceptions of the managers, their adaptation to changing circumstances, their understanding of the larger context in which ranches operate, their experience and technical knowledge, and the manage-

ment practices they engage in.[31-34] Social sciences can aid in understanding these within the context of the understudied new faces of rangeland managers.

*Values and perceptions*—Values and perceptions guide human behaviors (notably within the constraints of policies, economic pressures, social norms, infrastructure, and many other factors).[35,36] Within rangeland management, the values and perceptions of managers can be instrumental in the acceptance or rejection of practices being promoted by other actors (e.g., extension agents, peer land managers, and county commissioners[37]). For instance, previous studies have shown cultural and family values can have an even stronger influence on management decisions than economic considerations.[4,38] With respect to the new faces of rangeland managers, salient questions related to values and perceptions include the following. How do social or cultural values of contemporary rangeland managers affect the implementation of operational practices? How have these values and perceptions changed from previous generations of managers? What values are most important to the new generation of managers with respect to making decisions about natural resource stewardship? Social science research has developed models, theories, and analytical methods,[35,36] which have helped uncover the connections between values, perceptions, and behaviors. For instance, social science research has found the implementation of environmentally responsible behaviors depends upon an internal locus of control, a strong sense of responsibility, a solid understanding of the issues and action strategies, and a positive attitude.[39] Further research has looked at these factors among different populations in different parts of the world within different contexts.[40,41] Social science models, theories, and analytical methods can be applied to assess the new managers' values and perceptions and connect them with decision-making and behaviors. For example, lifestyle-oriented landowners have been found to be less likely to adopt grazing, vegetation management, restoration, and water management practices as compared with production-oriented landowners. Such findings reflect both potential opportunities and challenges, as natural resource managers strive to deliver meaningful education and outreach opportunities.[21]

*Understanding of the larger social, economic, and environmental context*—A rangeland manager's decision-making is influenced by their understanding of the larger social, economic, and environmental context (e.g., global markets, fuel costs, urbanization, and climate change) within which ranching operations take place.[2] Successful achievement of economic and ecological goals within ranching operations depends on how well managers can respond and adapt to rapid and complex changes in socio-environmental conditions surrounding their operations.[2] For instance, in the context of climate variability, Risbey et al.[42] noted farmers who understood the multiscale contexts in which ranches operate outperformed their counterparts who were less informed. There is, however, conflicting evidence in regards to how much young generations are interested in current events. Some studies indicate many young Americans are relatively disengaged in learning about current events, while others, particularly with the increasing demand and access to cell phones and the internet, seem to be highly interested in current events.[43,44] It is important to understand which of these behaviors applies to the new faces of rangeland managers and how it affects their decision-making. Questions social science research can ask about the new demographic of managers include the following. Does the manager understand and pay attention to/inform him/herself of the factors beyond the ranch influencing their decision making? How can information about the broader context in which ranches operate be presented in a way that interests the understudied generation of managers and informs their management practices?

*Adaptation*—Related to the broader contexts in which ranches operate, understanding the rangeland manager's adaptability to such conditions is also critical.[5,11,45,46] Changes occur across time and space (e.g., within the ranch, community, region, state). Thus, the sustainability of ranches and their working ecosystems is affected by managers' abilities and desires to make adaptive management decisions that cope with changes.[4,46] While adaptive management is widely advocated, research on the degree to which it is actually practiced has historically focused on the economic and ecological dimensions of rangelands[5] with less focus on the broader social factors driving the individual manager's adaptive management choices. This shortcoming could be addressed through the inclusion of social science literature including co-management[47] and resilience[48] in the study of social determinants of adaptation. This addition can serve to further complement and strengthen the existing adaptation literature to improve our understanding of the "why" and "how" the new faces of rangeland managers adapt to changing circumstances. For instance, collaborative management, which has been proposed as an adaptation mechanism, places its attention on the synergic processes leading to adaptation. Collaborative management focuses its attention on the collective work of agencies, land managers, scientists, and other stakeholders, and examines how such interaction leads to adaptation.[5,49] Questions social science research can help address include the following. What are the mechanisms new rangeland managers are using to adapt to changing circumstances? Do the new faces of rangeland managers adapt through individual or collective strategies?

*Experience and technical knowledge*—Critically important to rangeland management success is the experience and technical knowledge of managers.[31] Such knowledge ultimately forms the basis of the practices rangeland managers engage in, which are highly relevant in the success or failure in attaining management goals. This is particularly relevant for the new rangeland managers, some of which may have very little experience or technical knowledge in land management at all.[12] For those who have been raised on family ranches, it is important to understand the quantity and quality of hands-on experience and technical knowledge they receive. How knowledgeable are new managers about current trends in rangeland management? What experience do they have? How effective is the intergenerational transfer of knowledge? How current is this knowledge? What barriers must they overcome to

acquire knowledge? Do some rangeland managers face different barriers than others, and if so, what factors contribute to such inequality? Social scientists can systematically examine these questions.

*Management practices*—Ultimately, successful rangeland management centers on ecological principles and practices that managers choose to implement to maintain healthy, functioning rangelands. It would be valuable to understand whether new rangeland managers tend to employ different management practices than previous generations. Roche et al.[4] found California rangeland managers identified livestock production as their highest priority and carbon sequestration among their lowest. Do the new faces of rangeland managers feel the same? Will the likelihood to prioritize carbon sequestration be higher among this population if paid by the government? Is there a generation gap in the emphasis placed on conservation practices? Do new managers understand the ecology of grasslands differently than previous generations, and if so, do management practices reflect this? Are the new faces of rangeland managers more likely to engage in collaborative management practices, and if so, why? What would make those collaborations succeed or fail? Are exurban migrants actively engaging in rangeland conservation practices? Or are they converting working ranches to recreational properties with little emphasis on natural resource management? Are the priorities of new managers with respect to agricultural production, conservation, recreation, and carbon sequestration different than those of previous generations?

## Rangeland managers and social institutions: Policy and outreach

As agroecosystems face increasing pressure to meet the demands of a growing human population, it is more critical than ever for rangeland managers to enhance their partnerships and communication with stakeholders and other important actors associated with the rangeland system.[4] We discuss the role social sciences research can have in understanding and informing the relationships rangeland managers have with outreach and policy, and the extent to which such understanding and informing influences the actual incorporation of knowledge into management decisions.[28,30] We focus on outreach and policy because of the roles they play in providing information and regulations influencing rangeland managers' decision-making.

Outreach is broadly understood as the work of bringing information and knowledge generated by researchers to the communities and practitioners who would benefit from it. Outreach activities can be conducted by cooperative extension agents, agricultural advisors, and community members. Outreach plays a large role in helping rangeland managers make better decisions to reach management goals. However, this information may not be incorporated if rangeland managers perceive distrust, differences in values, miscommunication, or a lack of access to reliable information. For instance, Briske et al.[5] noted the decades-long persistence of the rotational vs. continuous grazing debate has been aggravated by terminological confusions, resulting in miscommunications and misunderstandings between land managers and outreach specialists. Such misunderstandings (as well as other reasons noted above) can cause land managers to value advice from peers to a greater extent than advice from extension officers.[50]

Policies, broadly defined as mandated courses of action, play a critical role in regulating what rangeland managers can or cannot do. As well-intended as they may be, no one policy is right for all situations.[4] Furthermore, even when a particular policy has been strongly linked to desirable ecological outcomes, rangeland managers may have negative opinions toward the policy or its enforcement. There is considerable potential for conflict between the goals of policy makers and rangeland managers.[5] To this point, Roche et al.[4] found California ranchers perceived environmental regulations and government policies as the biggest threats to the future of their operations. Thus, it is important to understand how outreach and policy can better serve the goals of contemporary range managers.

Exploring factors mediating relationships among rangeland managers, outreach entities, and policy makers is important because they affect the way natural resources are managed and, ultimately, the quantity and quality of socio-economic benefits derived from the rangeland system. Here, we focus on trust, communication, and the type of interaction existing among rangeland managers, outreach, and policy. Social science research can assist in understanding the role these factors play in the acceptance or rejection of information, knowledge, and policies leading to better socioeconomic and environmental outcomes in managing rangelands.

*Trust*—Based on our framework, the first factor mediating the interactions between individuals/social actors is trust.[46,51,52] Ghorbani and Azadi[52] described trust as a "lubricant" facilitating collaboration among actors. Lack of trust, on the other hand, often leads to rejection of information and policies, broken partnerships, and failed initiatives.[3,28,29] Specifically in the case of policy and trust, social science research has found a positive relationship between trust and policy acceptance by managers. Lien et al.[46] noted within the context of adaptive management (AM) on public lands:

> *Trust played a clear and powerful role in respondents' opinions about the impacts of AM and how it was being implemented on USFS allotments. Respondents who did not trust USFS personnel generally regarded the agency's AM policy as unfair, ineffective, or nonexistent in practice. In contrast, those who had strong trust relationships with USFS personnel or felt like they could build such relationships generally spoke highly of the AM policy and thought its implementation was a step forward in co-management of allotments between the agency and permittees.*

Trust entails a two-way relationship between actors. Trust between rangeland managers and policy makers can influence policy compliance by rangeland managers as well as the timing and content of enacted laws by policy makers. In a study of the factors predicting the decision of a county commissioner to enact fire bans, McDaniel et al.[30] found landown-

ers wishing to use prescribed fire could forestall fire bans by building trust with local officials through demonstrating their ability to conduct such fires safely. Thus, understanding how to improve trust between rangeland managers and policy makers extends beyond explaining and predicting rangeland managers' attitudes in relation to policies. It also means understanding what helps policy makers develop trust in the capacities, motivations, and goals of rangeland managers. Following this, social science research can focus on both the policy maker and the intended policy recipients to understanding how trust is formed or damaged between actors. This understanding is particularly important in the context of the new faces of rangeland managers. New rangeland managers and policy makers may have little historical or experiential reason to trust one another.[30] Questions to be asked by social scientists include the following. What makes rangeland managers trust the institutions enacting the policies that affect them? Do policy makers trust the capacities, motivations, and goals of rangeland managers? What factors influence the degree of trust between these actors?

Relationships of trust also play a critical role in determining how rangeland managers accept or reject information provided by outreach entities.[29] Ghorbani and Azadi[52] noted "trust improves knowledge sharing and learning," which is key for obtaining the goals of outreach programs. As with policy makers, trust relationships between outreach actors and rangeland managers are two-way. There remains considerable opportunity to better understand the factors that, on the one hand, predict land manager's trust in the information provided by outreach agents, and on the other hand, the outreach agent's trust in rangeland managers' knowledge, motivations, and expressed needs for a particular training/education. Addressing this gap is critical for improving the effectiveness of outreach programs. Beyond the educational aspect of outreach, trust plays other important roles in the relationship between outreach and rangeland managers. For instance, Fernández-Giménez[53] found rangeland managers characterized outreach agents as "objective, unbiased, professional, and of high integrity," leading to trust that in turn allowed agents to mediate conflicts between different groups and individuals. That is, social science research can enhance our understanding of how the trust relationship between rangeland managers and outreach extends beyond educational goals, and further help rangeland managers reach their ecological and economic goals. Fernández-Giménez[53] called for further research to "determine causal relationships and the strength of Extension's influence on permittee behavior." As in the case of the relationship between policy makers and the new faces of rangeland managers, a particular challenge pertaining to trust is the time needed to develop trusting relationships. Building relationships of trust between new rangeland managers and outreach agents could be hampered by high turnover rates among county agents. On average, county agents currently hold their positions for <6 months—a stark contrast to 30-year periods for previous generations of agents.[54] Questions to be asked by social scientists to understand trust between contemporary land managers and outreach agents include the following. To what extent do rangeland managers trust the outreach institutions providing information to them? Do outreach actors trust rangeland managers' knowledge, motivations, and expressed needs for education? What factors influence the degree of trust between these actors?

*Communication*—Effective communication contributes to strong relationships among rangeland managers, outreach agents, and policy makers. A vast literature underscores the role of communication in making or breaking relationships and professional projects (reviewed by Luhmann[55]). However, few studies have sought to understand how social institutions and rangeland managers communicate. Improving communication among these actors will likely translate to improved trust.[56] Roche[11] calls for a rejection of the historical trend of communicating within silos and branching out to other disciplines and actors to develop responses to the complex issues faced by rangeland managers. Often there are strong correlations between the knowledge different stakeholders have about a specific issue.[57] Coupled with a growth in methodological and technological tools, communication can be improved to help rangeland professionals better access and understand the information presented to them.

The way policies are communicated also influences the extent to which rangeland managers accept or reject them. A "science communication problem" exists when scientifically supported facts relevant to policy are disputed or rejected because they conflict with political or other cultural influences.[58] Science communication problems are rampant in natural resource management. For instance, in Florida and Georgia, Hundemer et al.[59] found individuals tended to accept statements of scientific knowledge regarding water conservation unless the statement activated partisan positions. We know little, however, about how the new faces of rangeland managers perceive communication about rangeland policies, and hence, the extent to which science communication problems exist. This challenge may be especially pronounced for exurban amenity migrants, who are often absent from their ranches.[60] How will these landowners become informed of new policies? What are the best mechanisms to facilitate the understanding and adoption of policies for the new rangeland managers? Is the new generation of rangeland managers more or less likely to accept and implement policy than previous generations? Which issues in contemporary rangeland management face science communication problems, and how can we overcome these problems?

Poor (e.g., limited, confusing) communication among rangeland actors (especially researchers, extension specialists, district managers, and land managers) can hamper productive outreach. For instance, researchers often complain, "no one uses my research," and ranchers often complain, "no one is doing research that matters to me." Both are often incorrect—a result of the lack of a universal communication mechanism occurring between them. A main goal of outreach is to inform and educate about technologies and methods to help the public achieve their goals. Academics have called for more innovative and effective methods of outreach communication.[11] Briske et al.[5] noted experiential learning opportu-

nities helped rangeland managers understand and eventually adopt best management practices. Bruno et al.[6] found stakeholder mapping improved the effectiveness of outreach activities by allowing extension personnel to identify relevant participants, their needs and interests, and their level of commitment. Roche et al.[4] reported among California ranchers, the most and least preferred methods of communication included printed publications and electronic sources, respectively. However, as the new faces of rangeland managers may prefer different communication forums than previous generations, this question needs to be raised continually as demographic groups shift. It is important to know how the diverse array of social actors now becoming part of the rangeland management system prefer to communicate, and how outreach specialists can facilitate this communication.

Ineffective communication can also hamper the adoption of effective management practices. If the science is sound but managers are not responding, there may be a science communication problem social science research can help overcome. For example, several state and federal agencies provide programs and technical information about prescribed fire, aiming to connect and educate private landowners and county officials about this rangeland management tool.[61] Technical information is an essential component of prescribed fire education and training, but these programs often fail to address how people value fire in general, specifically, prescribed fire. People are most likely to retain and incorporate information when it resonates on an emotional level.[62] Therefore, to be most impactful, outreach agents may need to address both the technical and emotional sides of learning.[62] Social science research can elucidate the best way of going about this. Approaching management strategies with a social dynamic not only makes learning more successful (e.g., achieving specific learning objectives), but builds trust and consistency in the relationship because impactful information is now being applied in a meaningful manner. This paradigm shift offers immense opportunity to effectively communicate management strategies to social actors without an agricultural background or those who may have had negative experiences with management tools like prescribed fire.

*Type of interaction*—Finally, trust and communication are highly related to the type of interaction among rangeland managers, outreach agents, and policy makers.[46] Interaction type refers to the way in which actors engage with each other, which can be top-down or bottom-up, one or two-way, imposed, or participatory. Social science research has produced a large amount of robust information in this area. Within the human dimensions of natural resources, researchers have reported that two-way participatory interactions (i.e., open dialogue between participants) tend to produce better outcomes than imposed (e.g., mandated) or one-way (e.g., top-down) interactions.[63] Roche[11] noted two-way interactions between researchers and land managers led to agreement on the success of rotational grazing. Roche et al.[4] noted "individuals and institutions that can effectively span different social networks have the opportunity to link diverse knowledge sources and goals and bring multiple groups together for the coproduction of knowledge." Particularly in the case of outreach, Briske et al.[5] noted the importance of outreach specialists working across the human dimensions of rangeland management to shape the dissemination and assimilation of knowledge.

This applies to policy as well. Andrade and Rhodes[64] observed individuals tend to comply better with policies and rules when they are included in the policy-making process. Rouillard et al.,[63] in discussing land use change policy to reduce flood risk, noted the benefits of participatory practices beyond policy compliance:

> *The research has demonstrated that participative processes can work in synergy with other policy instruments, such as regulations and economic instruments, and thereby con- tribute to improved policy compliance, greater uptake of rural land management techniques, and better relations between agencies and land managers.*

However, fostering public participation in program development presents unique and multifactorial challenges present at the individual level (e.g., feelings of marginalization, believing participation will not lead to desired outcomes, shortage of time and/or interest, and lack of trust), at the institutional level (e.g., costs, logistical complexities, and difficulty in attracting participants), and at the social level (e.g., lack of a social and political culture that fosters the right and duty of citizens to participate).[65] Social science research is well positioned to leverage an extensive literature on the frameworks, typologies, and methods of designing, implementing, assessing, and evaluating participatory practices.[66,67] Much of this knowledge has been successfully applied to the fields of community planning, tourism, forestry, and conservation.[68-70] However, we know little about how participatory practices should be designed, promoted, and executed among the understudied and unknown populations of new rangeland managers. Standing questions include the following. Are interactions among rangeland actors collaborative and/or participative? What are the barriers to two-way interactions? How strong are these barriers and how can they be removed? What models of interaction work best with the new generation of managers? Are policy makers including the knowledge and opinions of rangeland managers when designing and implementing policies? What are the best ways to engage in inclusive and participatory practices with managers when designing policies?

## Conclusions

Rangelands are coupled socio-ecological systems. Thus, more fully integrating and centralizing social science research into rangeland issues has considerable potential to improve relationships among rangeland managers, outreach agents, and policy makers, with the end goal of improving management of rangeland ecosystems and producing the socioeconomic benefits derived therefrom. Contemporary rangeland managers are demographically distinct from previous generations. We know very little about how the rising generation of rangeland managers think and act in relation to their ranching op-

erations. Understanding the new faces of rangeland managers entails understanding the relationships contemporary rangeland managers have with social institutions and the natural resources they manage. Social science research can provide the knowledge, theories, and methodologies needed to assist the different actors in the rangeland system in understanding, informing, and incorporating decision-making to reach their economic and ecological goals.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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