Original Research

Collaborative Adaptive Rangeland Management Fosters Management-Science Partnerships☆

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ABSTRACT

Rangelands of the western Great Plains of North America are complex social-ecological systems where management objectives for livestock production, grassland bird conservation, and vegetation structure and composition converge. The Collaborative Adaptive Rangeland Management (CARM) experiment is a 10-year collaborative adaptive management (CAM) project initiated in 2012 that is aimed at fostering science-management partnerships and data-driven rangeland management through a participatory, multistakeholder approach. This study evaluates the decision-making process that emerged from the first 4 yr of CARM. Our objectives were to 1) document how diverse stakeholder experiences, epistemologies, and resulting knowledge contributed to the CARM project, 2) evaluate how coproduced knowledge informed management decision making through three grazing seasons, and 3) explore the implications of participation in the CARM project for rangeland stakeholders. We evaluated management decision making as representatives from government agencies and conservation nongovernmental organizations, ranchers, and interdisciplinary researchers worked within the CARM experiment to 1) prioritize desired ecosystem services; 2) determine objectives; 3) set stocking rates, criteria for livestock movement among pastures, and vegetation treatments; and 4) select monitoring techniques that would inform decision making. For this paper, we analyzed meeting transcripts, interviews, and focus group data related to stakeholder group decision making. We find two key lessons from the CARM project. First, the CAM process makes visible, but does not reconcile differences between, stakeholder experiences and ways of knowing about complex rangeland systems. Second, social learning in CAM is contingent on the development of trust among stakeholder and researcher groups. We suggest future CAM efforts should 1) make direct efforts to share and acknowledge managers' different rangeland management experiences, epistemologies, and knowledge and 2) involve long-term research commitment in time and funding to social, as well as experimental, processes that promote trust building among stakeholders and researchers over time.

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Introduction

Substantial differences between the goals and methodologies of rangeland science and rangeland management have limited their integration throughout the history of the rangeland profession. Science and management are not directly comparable endeavors (Provenza, 1991), so the development of knowledge that is legitimate to managers and that scientifically supports management actions is a formidable challenge. Although there has been considerable experimental research focusing on specific aspects of grazing management, these studies have not included the decision-making and learning processes central to grazing management (Briske et al., 2008, 2011; Brunson and Burritt, 2009). Therefore, research and monitoring approaches need to document explicitly the processes of adaptive management to enrich

our understanding of successful grazing management (Brunson and Burritt, 2009; Budd and Thorpe, 2009).

Participatory research approaches that promote mutual learning through collaboration between researchers and stakeholders could create opportunities to bridge the gap between rangeland science and management (Ballard and Belsky, 2010; Shirk et al., 2012). One such approach is collaborative adaptive management (CAM), which, as implied in the name, aims to reduce uncertainty in complex ecosystem management by combining participatory and collaborative processes with adaptive management (Stringer et al., 2006; Armitage et al., 2009; Beratan, 2014). This paper first outlines and then evaluates the claims that CAM can effectively promote learning and reduce uncertainty among diverse interests in rangeland management by examining a single application of CAM, the Collaborative Adaptive Rangeland Management (CARM) experiment. CARM is a 10-yr, interdisciplinary project (initiated in 2012) conducted at the US Department of Agriculture — Agriculture Research Service (ARS) Central Plains Experimental Range, a Long-Term Agro-ecosystem Research (LTAR) network location on the shortgrass steppe of eastern Colorado.

This paper is a case study, based on qualitative social data collected from meeting notes and interview transcripts recorded in CARM. In this synthetic assessment, we explore to what extent participation in the CARM experiment enabled adaptive decision making by a group of rangeland stakeholders. The specific objectives of this study were to 1) document how diverse stakeholder experiences and epistemologies (meaning their socially constructed theories and justifications for rangeland management knowledge) contribute to the CARM project, 2) evaluate how coproduced knowledge informed management decision making through three grazing seasons, and 3) explore the implications of participation in the CARM experiment for rangeland stakeholders.

Collaborative Adaptive Management Framework

CAM is a framework to link rangeland stakeholders and scientists in a shared process of learning by doing (Stringer et al., 2006; Armitage et al., 2009; Knapp et al., 2011; Beratan, 2014). CAM explicitly incorporates experimental design in the implementation of management treatments and collaborative decision-making processes (Hopkinson et al., 2017). Conventional engagement of rangeland managers by agencies and academics often centers on extension bulletins, presentations, or popular press articles produced after research has been completed. In contrast, CAM, when implemented as participatory research, seeks to connect researchers and managers throughout the research process and empower stakeholders to develop new knowledge and take ownership of research results (Uphoff, 1986, 2002; Wilmsen et al., 2008). Next, we discuss the theoretical contributions of adaptive management, participatory research approaches, and collaborative processes to the CAM framework.

Adaptive Management To Reduce Uncertainty in Complex Systems

Adaptive management is a formal process whereby managers work to reduce uncertainty through systematic learning of system function by adapting management actions to new information learned from management outcomes (Gunderson, 2000; Jacobson et al., 2009). This approach represents an alternative to command and control management and assumes that complex natural systems cannot be effectively controlled via prescriptive actions (Holling and Meffe, 1996). Adaptive management is often discussed in a complex social-ecological systems perspective with an emphasis on the concept of "loop learning" (Petersen et al., 2014), the process by which new information is used to alter management actions (single-loop learning), revise guiding assumptions about the management context in question (double-loop learning) (Argyris, 2002), or inspire higher level reflections on the context and power of the management process (triple-loop learning) (Roux et al., 2010). Adaptive management has been celebrated as an

alternative to trial and error approaches to managing complex systems, but common pitfalls in the implementation of adaptive management have been identified. These include insufficient monitoring, failure to maintain stakeholder engagement and acknowledge that managers are risk averse, and lack of institutional commitment to use learning to modify management (Allen and Gunderson, 2011; McFadden et al., 2011). Adaptive management is also restricted when academics learn among themselves rather than with external stakeholders (Fabricius and Cundill, 2014).

Participation to Increase Engagement

The collaborative aspects of CAM respond to some of the limitations of adaptive management to address complex natural resource issues in the face of uncertainty and conflict (Susskind et al., 2012). CAM employs iterative (Plummer, 2009), participatory and consensus-based decision-making frameworks that include multiple hypotheses and sources of knowledge (Bouwen and Taillieu, 2004; Leys and Vanclay, 2011; Cundill et al., 2012; Bennett, 2016). The major premise is to increase stakeholder engagement and ownership in research, as evidence suggests that stakeholders' level of engagement, and not time involved in collaborative research, is a major driver of learning outcomes (Evely et al., 2011).

Various forms of rancher participation have been included in rangeland research in the United States since the early 20th century (Sayre, 2017). However, the paradigm of participatory research gained traction in crop agriculture, health, and development fields in the 1970s and has grown to become a stakeholder engagement orthodoxy across a number of disciplines (Gow and Vansant, 1983; Uphoff, 1986; Cornwall and Jewkes, 1995), including natural resource management (Ballard and Belsky, 2010; Knapp et al., 2011). This type of research focuses on processes of change, including ongoing adaptation, evaluation, and outreach built upon collaborative relationships among managers, researchers, and/or nongovernmental organizations (NGOs; Uphoff, 1986, 2002; Wilmsen et al., 2008). Participatory research reorganizes the traditional view of science in terms of who conducts, analyzes, and presents research and for whose benefit this knowledge is produced and recorded (Cornwall and Jewkes, 1995; Cornwall, 2003). Participatory processes emphasize decentralization, transformation, empowerment, integration of local knowledge, and application of research to locally relevant management scales (Cornwall and Jewkes, 1995) and are thus a natural fit for the challenges of linking rangeland management and science across social, spatial, and temporal scales.

Collaboration to Increase Learning

A key contribution of CAM is to wed adaptive management, in which management actions are treated as experiments, with stakeholder collaboration to foster social learning. We define social learning as the processes in which individuals and groups work together to critically evaluate existing norms, values, institutions, and interests, and thereby to coproduce new knowledge, develop a shared understanding, and take collective action (Muñoz-Erickson et al., 2010; Cundill and Rodela, 2012; Nykvist, 2014). In the collaborative rangeland management context, stakeholders bring management knowledge formed through diverse management experiences to new decision-making contexts involving multiple, and seemingly contradictory, goals (e.g., grassland bird conservation and beef production). In these complex management contexts, social learning becomes a key concept to help bridge knowledge gaps among stakeholders (Fernandez-Gimenez et al., 2006; Edelenbos et al., 2011).

The collaborative and participatory aspects of the CARM project design rely on numerous examples of collaborative, participatory, and community-based agriculture, rangeland, and other common-pool resource management work conducted over the past three decades (Ostrom, 1990; Fernandez-Gimenez et al., 2006; Arnold and Fernandez-Gimenez, 2007). Advances in conceptual development of these approaches in rangeland contexts derive largely from experiences of international development (Coppock, 2016) and recent work in the