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Informal Rangeland Monitoring and Its Importance to Conservation in a U.S. Ranching Community☆

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ABSTRACT

Effective natural resource management relies on accurate and timely information on the natural environment, which may be obtained by formal ("scientific") or informal ("local" or "traditional") methods. Formal monitoring methods are well documented and widely accepted among the rangeland science community, yet adoption by U.S. ranchers is inconsistent. In contrast, informal monitoring appears to be widely used by ranchers, but its practice and importance have rarely been documented or assessed. By interviewing ranchers and government agency personnel, we evaluated informal monitoring in and around the Altar Valley, Arizona, United States. Informal monitoring techniques included qualitative visual appraisals of forage quantity, indicator species and erosion, and incorporated local environmental history. The environmental knowledge embedded in informal monitoring was generally compatible with natural science. Informal monitoring was conducted continuously throughout the year and provided near real-time assessments that integrated observations of most land in individual pastures and ranches. In contrast, formal monitoring was generally performed only once per year, in a limited number of areas and with a delay of a few months between observation and completion of analysis. Thus informal monitoring had higher spatial coverage and temporal resolution and provided assessments faster than formal monitoring. Consequently, ranchers generally considered informal monitoring to be more relevant than formal monitoring to formulating yearly grazing plans and responding rapidly to unpredictable changes in the natural environment. Ranchers incorporated informal monitoring into assessments of rangeland trends and outcomes of conservation measures and thereby into choices of grazing system and planning of brush management and erosion control. Thus informal monitoring was foundational to long-term conservation, annual rangeland management planning, and adaptive natural resource management on subyearly timescales. If informal monitoring is of comparable utility in other rural communities, it would appear advantageous to document and evaluate informal approaches and to incorporate them into formal conservation planning.

Introduction

Rangeland monitoring is foundational to informed, deliberate management of rangelands (Elzinga et al., 1998; Holechek et al., 2004). Monitoring enables pasture and livestock management decisions to account for the condition of land, its plants, animals and soils, and their responses to human activity and the wider natural environment. Of the various techniques available, formal ecological monitoring is well understood (Coulloudon et al., 1999a; Holechek et al., 2004; Lindenmayer and Likens, 2010), and informal or traditional methods have often been studied in nonindustrialized or indigenous societies (Berkes et al., 2000; Thornton and Scheer, 2012). Informal environmental knowledge and monitoring in industrialized societies are less commonly studied but can play an important role in natural resource management (Ballard et al., 2008; Meuret and Provenza, 2015; Millar and Curtis, 1999). Informal rangeland monitoring appears widespread among U.S. ranchers, but its practice, uses, and value have rarely been documented or assessed (Knapp and Fernandez-Gimenez, 2008, 2009; Sayre, 2004).

For our purposes, formal monitoring is defined as standardized procedures based in the scientific method and widely accepted and used among natural resource management professionals in academia and government agencies (Raymond et al., 2010). Procedures are well documented, consistently repeatable and, usually, quantitative and amenable to statistical analyses, thus minimizing bias and dependence on place or practitioner (Ruggiero, 2009). Formal rangeland monitoring methods are developed, practiced, and promoted by, among others, the academic community and by U.S. federal agencies within the Department of Agriculture and the Department of the Interior (Coulloudon et al., 1999a; Holechek et al., 2004; Lindenmayer and Likens, 2010; USDA-NRCS, 2003; USFWS, 1980). Formal monitoring can be effective in assessing and improving natural resource management, though efficacy is not guaranteed in all circumstances and cost can be prohibitive

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(Elzinga et al., 1998; Lindenmayer and Likens, 2010). Published data on adoption by U.S. ranchers are scarce, but available data suggest it is used on approximately half the livestock ranches in Arizona (Fernandez-Gimenez et al., 2005; Peterson, 2010).

In contrast, informal monitoring is nonstandardized, relies on personal practice and experience, is typically embedded in local cultural and natural environments (Raymond et al., 2010), and is practiced on approximately 95% of ranches in Arizona (Peterson, 2010). Informal knowledge of the natural environment may be localized and may or may not be compatible with natural science (Ellis, 2005; Sillitoe et al., 2004), and informal monitoring procedures typically do not conform to the scientific method (Raymond et al., 2010). The degree of compatibility between informal knowledge and natural science is variable and should not be assumed (Raymond et al., 2010; Tibby et al., 2008). Thus informal monitoring is vulnerable to charges of practitioner bias and unreliability, and is typically not officially sanctioned by government agencies (Ruggiero, 2009).

Informal or traditional monitoring can, however, have advantages over formal monitoring, including greater effective sample sizes (in a broad sense, in terms of numbers of plants, animals, and areas observed), longer duration and greater frequency of observation, integration of greater variety of observations, and lower cost (Moller et al., 2004), attributes that can increase the effectiveness of monitoring as a tool for understanding ecological change and its causes (Elzinga et al., 1998; Herrick et al., 2006; Lindenmayer and Likens, 2009; Vaughan et al., 2001). Thus informal and formal monitoring may be to some extent complementary, and incorporation of both systems may improve the management of natural resources (Reed et al., 2013).

If informal and formal methods are to be integrated systematically, informal methods must first be clearly identified and their validity or compatibility with formal methods assessed (Raymond et al., 2010; Sillitoe et al., 2004). It is common to equate the validity of traditional environmental knowledge with its degree of conformance to formal science (Ellis, 2005; German, 2010). However, this approach is controversial because disagreements between the two knowledge systems can be due to inadequacies of formal science (Ellis, 2005; Fairhead and Scoones, 2005). There can also be disagreements within natural science. For instance, formal field monitoring can correspond more closely to informal monitoring than to remote sensing assessments of rangelands (Herrmann et al., 2014; Kong et al., 2015). Therefore bias in favor of either informal or formal monitoring should be minimized, for example, by assessing compatibility between the two systems rather than treating one system as a benchmark or standard reference (Ellis, 2005). Then, apparent contradictions between informal and formal knowledge would represent opportunities to re-evaluate and refine both sets of observations and conclusions, and thereby improve or correct either or both of them.

Formal rangeland monitoring methods are typically evaluated and selected with reference to their purpose or application, whether in ecological research or natural resource management (Elzinga et al., 1998; Lindenmayer et al., 2011). We suggest that informal monitoring should be similarly evaluated in the context of its uses. Informal monitoring typically varies between practitioners and regions (Raymond et al., 2010). In this study our objective was to document the informal rangeland monitoring practiced in one ranching community and compare it with formal monitoring and natural science. We used qualitative methods (Patton, 2002; Sayre, 2004) to gain detailed, in-depth understanding of informal rangeland monitoring practices, the application of informal and formal monitoring to rangeland management, and the perspectives of participants on their utility. We compare informal and formal monitoring in the study area, and compare informal monitoring with published literature on formal monitoring and natural science. Thereby, we assess the compatibility and complementarity of the two monitoring systems and their utility to local rangeland management and conservation. We submit that such description and analysis are necessary if we are to determine whether it is feasible and meritorious to integrate the two methodologies or their outcomes (Ellis, 2005; Huntington, 1998).

Methods

Biophysical Setting

The study area comprises the Altar Valley and adjacent rangelands in the Santa Cruz Valley in Pima and Santa Cruz counties, Arizona, United States. The area lies west of 111.1°W and south of 32.0°N; borders the Schuk Toak, Baboquivari, and Chukut Kuk districts of the Tohono O'Odham Nation to the west and Mexico to the south; and totals approximately 2 300 km^2 (900 square miles). Landforms include mountains of up to 2 350 m elevation, pediments, alluvial fans, and a floodplain down to 750 m elevation (Andrews, 1937; Sayre, 2007). Mean annual precipitation varies with elevation and ranges from 300–650 mm (NOAA-NCDC, 2012). Peak precipitation occurs between July and September in the monsoon season, with a smaller peak in winter and a pronounced spring dry season. Mean daily temperature ranges from 4–10°C in January and 21–32°C in July (NOAA-NCDC, 2002).

Vegetation communities vary from *Quercus-Pinus* (oak-pine) and oak savanna at higher elevations to herbaceous and wooded riparian areas along principal channels, with desert scrub and semidesert grassland and savanna being the predominant rangeland types (Meyer, 2000; Strittholt et al., 2012). Grasslands in the region have changed considerably since the early 20th century. Many are now dominated by the nonnative Lehmann lovegrass (*Eragrostis lehmanniana* Nees.), while others have undergone considerable encroachment by native woody plants, particularly velvet mesquite (*Prosopis velutina* Woot.). Other common woody plants include the shrubs catclaw acacia (*Acacia greggii* A. Gray.), paloverde (*Parkinsonia* spp.), ocotillo (*Fouquieria splendens* Engelm.), and prickly pear cactus (*Opuntia* spp.), and the subshrubs huajillo (or fairyduster, *Calliandra eriophylla* Benth.), burroweed (*Isocoma tenuisecta* Greene), and snakeweed (*Gutierrezia* spp.). Common native grasses include threeawns (*Aristida* spp.), sideoats grama (*Bouteloua curtipendula* [Michx.] Torr.), tanglehead (*Heteropogon contortus* [L.] P. Beauv. ex Roem. & Schult.), and sacaton grass *(Sporobolus wrightii)*.

Social Context

The study area is predominantly rural and includes the small town of Arivaca. Cattle ranching has been a major industry since the early 19th century (Sheridan, 1995) and is currently the most extensive land use. The majority of rangelands in the area are Arizona State Trust lands, administered by Arizona State Land Department (ASLD) and leased to ranchers for livestock grazing (USDA-NRCS et al., 2008). Private ranches and the Buenos Aires National Wildlife Refuge (BANWR) account for most of the remaining area, with smaller holdings under the jurisdiction of the U.S. Department of Agriculture (USDA) Forest Service (USFS), Pima County and the U.S. Department of Interior Bureau of Land Management (BLM). Most livestock ranches utilize a combination of State Trust land and private land, with some also grazing USFS, BLM, or county lands. The 12 largest ranches in the Altar Valley cover approximately 125 km^2 on average, including both private and public land (Sayre, 2007). BANWR is administered by the US Fish and Wildlife Service (USFWS) and is closed to livestock grazing. Other government agencies involved in local rangeland management include the USDA Natural Resources Conservation Service (NRCS) and Arizona Game and Fish Department (AGFD). The Altar Valley Conservation Alliance (AVCA) provides a forum for members of the local ranching community, NGOs, representatives of government agencies and others who aim to cooperate in rangeland conservation.

Data Collection

We conducted 28 semistructured, conversational interviews (Wilson and Sapsford, 2006) with 27 participants between February 2010 and January 2011. Interviews were semidirective, allowing both participant and interviewer to cooperatively direct the interview into