Rangeland Ecol Manage 65:543–544 | November 2012 | DOI: 10.2111/REM-D-12-00112.1

Big Questions Emerging from a Century of Rangeland Science and Management

Brandon T. Bestelmeyer,[1] Rick E. Estell,[2] and Kris M. Havstad[3]

Authors are [1]Research Ecologist, [2]Research Animal Scientist, and [3]Supervisory Scientist, USDA-ARS Jornada Experimental Range, Las Cruces, NM 88003, USA.

This special issue commemorates the centennial of the Jornada Experimental Range. The Jornada and several other rangeland research stations were created early in the 20th century in response to broad concern that rangelands had been degraded. As a consequence of earlier policies to promote agricultural use in the western United States, including the Homestead Act and its subsequent revisions, much of the region experienced a rapid social-ecological transition from a sparsely populated landscape to one organized around intensive livestock production. The consequences of this transition were not well understood. Professor Elmer Wooton of the New Mexico College of Agriculture and Mechanic Arts (now New Mexico State University) was among the early visionaries to describe the new social-ecological system in the southwestern United States (Fig. 1). He sought to establish the Jornada Range Reserve within the US Department of Agriculture in order to learn how Southwestern ecosystems could be managed sustainably for food and fiber production. What was later named the Jornada Experimental Range was formed in 1912 by executive order of President Taft. In collaboration with a rancher of the Jornada Basin, Charles Turney (Fig. 2), this new facility addressed the big questions of that era: how to minimize livestock losses during drought; how to maximize use of forage species while sustaining them; how to determine the appropriate carrying capacity of arid grasslands; how to manage livestock distribution within a landscape. These questions represented the foundation of rangeland science, which evolved through the 1950s drought, the environmental revolution of the 1970s, and technological innovations of recent decades. Now, in the first years of the 21st century, we are witnessing transitions no less disconcerting than those described by Wooton a century before. Rangeland science is called upon once again to interpret rapid and substantial ecosystem changes and to develop management strategies to cope with them.

We use the Jornada centennial as an opportunity to reflect on the history of rangeland science and how it prepares us to answer the big questions of our time. We asked 56 researchers from seven countries to discuss a set of questions conveyed in the titles and main themes of the papers in this special issue. Nathan Sayre and colleagues introduce the special issue by framing the science that responded—often successfully—to the questions posed at the turn of the 20th century. They argue that the nature of the problems faced in the 21st century will require increasing attention to site specificity, a plurality of stakeholders and ecosystem services, and uncertain future conditions.

What are the key challenges facing rangeland managers in the 21st century? Rick Estell and colleagues show that, at a global scale, livestock numbers have been increasing dramatically even as the area of productive rangeland has likely decreased as a consequence of land-use conversion and woody plant encroachment. In addition to the application of fundamental rangeland management principles and technological innovations, adaptation to irreversibly changed conditions will be necessary. Andrew Ash and colleagues echo this theme and argue that in the face of directional climate change, we should consider the possibility that policies addressing rangeland use should be radically changed.

The need for social transformation is also addressed by Jayne Belnap and colleagues, who discuss the deliberate and accidental introduction of new species, and the loss of historical ones, that alter the character and function of ecosystems. In contrast to the singular vision of the historical climax as the unquestioned management goal, the management of novel ecosystems must ultimately be directed by heterogeneous groups of stakeholders that weigh the costs and benefits of often uncertain outcomes. Stakeholder engagement will be essential for effective identification, management, and valuation of ecosystem services. Sam Fuhlendorf and colleagues show that a singular focus on a particular ecosystem service, such as livestock production or carbon sequestration, can lead to negative outcomes regarding other services, particularly biodiversity. On the other hand, growing population and rising food and energy prices are driving the conversion of rangelands to radically different land uses, such as croplands and energy farms. Jeff Herrick and colleagues consider that some of these uses may ultimately diminish the long-term capacity of rangelands to support either agriculture or biodiversity. They argue that the work of rangeland professionals must not be limited to present rangeland uses and should be relevant to vulnerable lands regardless of their current use.

How can we use existing knowledge to manage rangelands toward desired conditions and sustain them? Often, we have not clearly identified the societal goals of management, the options that are realistically available, or even how rangeland systems are likely to respond to specific interventions. To address these limitations, Tom Monaco and colleagues suggest that the rangeland profession should develop systems to learn from management and restoration actions in rangelands, including their successes and failures, based on tools such as ecological site descriptions and state-and-transition models. Management strategies must also be considered in a sociopolitical context. Don Bedunah and Jay Angerer suggest that the selection of management approaches in developing countries must be based on knowledge of local institutions, particularly land tenure and governance, in addition to biophysical constraints and stakeholder needs. Failures in international development can often be traced to a foreigner's ignorance of existing in-country institutions.

The papers in this feature collectively echo Sayre and colleagues' argument that reductionist science approaches, while still necessary, are not sufficient to support rangeland management in the 21st century. If so, then what can the rangeland discipline do differently? Deb Peters and colleagues suggest a

The authors served as organizers for the special issue and thank David Briske, the journal's staff, and the editorial board for their excellent editorial support.

Correspondence: B. T. Bestelmeyer, USDA-ARS Jornada Experimental Range, MSC 3JER, Box 30003, New Mexico State University, Las Cruces, NM 88003, USA. Email: bbestelm@nmsu.edu

Manuscript received 27 August 2012; manuscript accepted 4 September 2012.

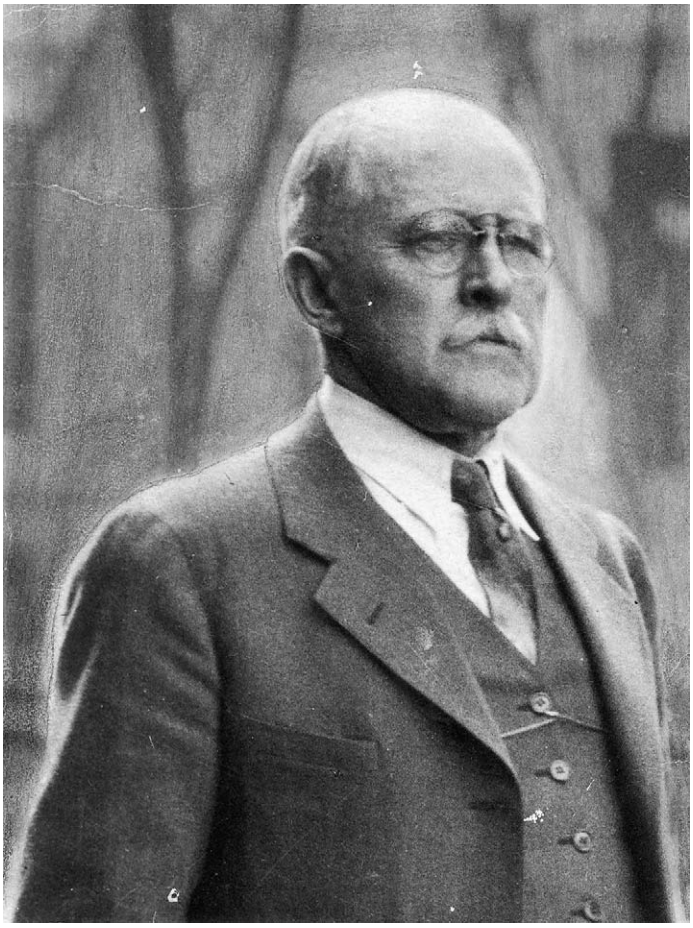

Figure 1. Elmer Ottis Wooton was born in 1865 in Kokomo, Indiana. From 1890 to 1911, he served as a professor and state botanist at the New Mexico College of Agriculture and Mechanic Arts, while making extensive observations of New Mexico rangelands. In 1912, while serving as an agricultural economist for the USDA in Washington, DC, he orchestrated the creation of the Jornada Range Reserve in collaboration with Charles Turney. Wooton returned to New Mexico to serve as the Jornada's Superintendent until 1915 when the Jornada was transferred to the US Forest Service. In addition to these roles, he produced 30 publications including the first floristic treatment of New Mexico and early arguments for the regulated use of public rangelands. He died in 1945 in Arlington, Virginia.

Figure 2. Charles Travis Turney was born in 1857 in Sutton County, Texas, and spent his life as a cowboy from the age of eight. He began ranching in Dona Ana County, New Mexico, in 1904 and held grazing rights on over 197 000 acres for his 4 000–5 000 head of cattle. Working with Wooton, Turney arranged to have 178 000 acres of public domain surrounding his holdings withdrawn for the Jornada Range Reserve. Turney served as the Jornada's first livestock cooperator and secured exclusive use of the area. Success during these early years led to expansion of his farming and ranching enterprises. Unfortunately, extended drought from 1916 to 1919 and a disastrous loss of cattle shipped into Mexico forced Turney to sell his interests in the Jornada in 1925. He died in 1930.

general strategy for linking location-specific science information (such as that produced within the Jornada site) with coarse-scale information (global climate data, networks of sites) via conceptual and simulation modeling to produce information that is useful at a variety of scales. We have to be more insightful and deliberate in matching existing information with the spatial and temporal scales at which it is needed and applied; recent technological advances and creative use of new and existing data will make this increasingly possible. Justin Derner and colleagues continue by asking why existing user-oriented models (e.g., of forage use) are not more effective or widely applied. They arrive at similar conclusions to those of Peters and argue for modeling efforts that can be interlinked and incorporate site-specific data from global spatial databases as they become available. Mark Brunson then offers a new kind of model—a model of whole social-ecological systems—as a potentially important tool for perceiving and communicating about rangeland complexity, including the social phenomena that drive human behaviors and land uses. Finally, Jason Karl and colleagues propose an integration of several technologies to make this broad array of information types available to users. They argue that our knowledge and the data upon which it is based should be more transparent and more broadly available.

Two papers conclude this special feature. Laurie Abbott and colleagues point out that the erosion of investment in university-based and other professional education is one of the greatest barriers to recognizing and responding to the complexity of rangelands. The linkage of rangeland education to the concepts, recommendations, and technologies presented in this special feature might reinvigorate rangeland training programs. Brandon Bestelmeyer and David Briske then integrate the primary themes in the preceding papers to identify a set of grand challenges for the rangeland profession. Confronting these challenges will require a collaborative, place-based, and knowledge-rich approach to facing uncertain future conditions, known as "resilience-based management." Ultimately, our success in developing resilient rangelands will depend on the collaborative production, sharing, and reevaluation of diverse sources of information—including local and scientific knowledge and the spatial data that connect knowledge to particular landscapes. Societal investments in these interlinked activities will ensure that the rangeland discipline is positioned to guide and inform rangeland stewardship in the 21st century.