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Ecosystem Services and Western U.S. Rangelands

Rhonda Skaggs

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Rangelands are expansive, unimproved lands located in arid or semi–arid regions, spanning a variety of landscapes including savannahs, high and low altitude deserts, mountain meadows, and tundra. Rangelands are generally unsuitable for crop production due to aridity, topography, and extreme temperatures. Rangelands support varying mixtures of native and nonnative grasses, grass–like plants, forbs, or shrubs which provide forage for free–ranging native and domestic animals (Stoddart, Smith and Box, 1975). There are more than 760 million acres of rangelands in the United States, including Alaska, comprising 33% of the nation's total land base (USDA–USFS, 1989a). While exact determinations are unavailable, it is estimated that more than 50% of U.S. rangelands are privately owned, 43% are owned by the federal government, with the remainder owned by state and local governments (National Research Council, 1994). Approximately 262 million acres of U.S. rangelands are controlled by the U.S. Forest Service (USFS) and the U.S. Bureau of Land Management (BLM) and leased to private individuals for the purpose of land–extensive livestock grazing (CAST, 1996). Many more acres of rangelands in the 11 western states1 are controlled by state or local government agencies and leased for livestock grazing, with all these states having a high degree of intermingled public and private ownership of rangelands.

Arid and semi–arid rangelands in the western United States are characterized by low and variable precipitation, high evaporative demand, nutrient poor soils, high spatial and temporal variability in plant production, and low net primary production (Havstad et al., 2007). These rangelands are often subject to desertification or invasion by shrubs and other woody plants as a result of drought, low resilience, and past management practices. Increased woody plant populations are strongly correlated with reduced forage availability for domestic livestock (primarily cow–calf, with some sheep and lambs) and wildlife grazing.

The public ownership of many western rangelands has led to ongoing, often contentious, policy debates regarding the ecological impacts of livestock grazing, and the types and levels of acceptable uses of the public lands. Given the nature of western rangeland ownership, it is often difficult to separate discussion of rangeland ecosystem services from discussion of public land policy. While western rangelands have been viewed primarily through the prism of livestock production, a broader awareness of the ecosystem services arising from rangelands has developed in recent years. This awareness has provided new grist for the public land policy debate, even though hard ecosystem services data for western rangelands remain elusive.

The concept of ecosystem services provides a framework for organized thinking about the relationships between humans and nature (Swinton, Lupi, Robertson and Landis, 2006) and for relationships within nature. Daily (1997) defined ecosystem services as "…the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life." The Millennium Ecosystem Assessment (2005) further developed the concept by defining the various categories of services human receive from the natural environment. Supporting ecosystem services which benefit people include nutrient cycling, soil formation, and primary production. These services in turn make provisioning, regulating, and cultural ecosystem services possible. Provisioning is the ecosystem's generation of food, fiber, fuel, and fresh water supplies. Regulating services include the ecosystem's role in providing pollination services, climate mediation, watershed functions (including flood control, storage, and filtering), and waste absorption and processing. The ecosys-

1 *Washington, Oregon, California, Nevada, Idaho, Montana, Wyoming, Utah, Colorado, Arizona, and New Mexico.*

tem also provides cultural services to humans, which include educational, aesthetic, spiritual, and recreational opportunities.

While forage production for domestic livestock has been a key ecosystem service of western U.S. rangelands, there is a broad array of ecosystem services forthcoming from rangelands. These services include wildlife habitat, recreation (including that associated with wildlife), watershed functions, carbon sequestration, and biodiversity conservation. As working lands, western U.S. rangelands have been managed primarily to generate provisioning (e.g., forage) ecosystem services now or in the future. Public policy controversies regarding western rangelands since the 1970s have been largely based on real or perceived trade–offs between provisioning (e.g., forage production and livestock products) and other ecosystem services (e.g., wildlife, recreation, biodiversity). Research has attempted to address these trade–offs; however, many questions remain unanswered even after decades of research. Thus, our ability to value and represent trade–offs through the use of traditional economic tools such as the production possibility frontier is limited. Furthermore, U.S. rangelands cover vast expanses of land, encompass numerous climatic, ecological, and vegetative types, and are extremely diverse. U.S. rangelands are located in remote areas distant from population centers, on the urban fringe, and everywhere between these two extremes throughout the West. Thus, the characteristics, quality, and quantity of ecosystem services arising from rangelands (as well as the value of the services) are highly variable. This diversity further complicates economic valuation efforts and the development of policies or programs designed to enhance the flow of ecosystem services from rangelands.

Valuation of Rangeland Ecosystem Services

About 20% of beef cattle in the United States, or six million head, are in the eleven western states (CAST, 1996). The USFS has estimated that less than 10% of total national forage consumption by domestic livestock is provided by public lands (USDA–USFS, 1989b). Torell, Fowler, Kincaid and Hawkes (1996) estimated that 15% of the nation's beef cows and 44% of the sheep and lambs were produced on public land ranches, that approximately 5% of the nation's grazing capacity comes from BLM and USFS lands, and that 4% of the forage for the nation's beef cow herd is supplied by these lands. While neither the overall national beef cow herd nor the national beef supply is greatly dependent upon public rangelands, many individual ranching operations in the inter–mountain West are almost 100% dependent upon total annual or seasonal forage provided by publicly–owned rangelands. Torell, Fowler, Kincaid and Hawkes (1996) also concluded that 41% of beef cows in the eleven western states grazed on federal lands for part of the year, and that 19% of the total annual forage demand in the region was met from federal land. From these numbers, aggregate estimates of the value of forage provided by public–domain rangelands can be made; although precipitation changes from year to year can greatly affect the values.

Rangelands represent a vast store of carbon, both in soils and vegetation (Havstad et al., 2007). The general conclusions of rangeland–related climate regulation research are that the carbon sequestration potential of rangelands depends greatly on appropriate management of the lands, minimizing degradation or desertification (including encroachment by undesirable species), and restoration or improvement of degraded rangelands (Follett, Kimble and Lal, 2001). Restoration of arid–region degraded rangelands is extremely difficult, and variability in precipitation throughout most U.S. rangelands adds additional uncertainty to the carbon sequestration regulating service provided by these lands. Although rangelands can contribute to carbon sequestration, the generally low productivity of arid rangelands also means that their sequestration potential is also lower than other types of land.

The first rangeland carbon credits pool was created in 2008, intended for sale on the Chicago Climate Exchange (CGX). According to AgraGate (2008), the company creating the pool, the number of carbon credits available from rangeland varies from 0.12 to 0.52 tons per acre, depending on soil types and precipitation. Ranchers wanting to sell carbon credits from rangelands must follow approved management plans designed to achieve targeted CO2 uptake levels. These management plans generally require reduced stocking rates, more dispersed livestock distribution, reduced forage utilization rates, and various rangeland improvements.

Rangelands continue to be largely natural systems; thus, all rangeland ecosystem services depend in some way on local biodiversity (Havstad et al., 2007). Given the diverse nature of rangelands and the traits of different species of flora and fauna present in rangeland ecosystems, it is not surprising that research has found both increases and decreases in biodiversity services as a result of livestock grazing and relative to varying grazing intensities. Endangered species and related biodiversity issues on rangelands are further complicated by situations where attempts to improve rangelands through shrub removal and restoration of natural grasslands reduces the preferred habitats of threatened or endangered species (e.g., the sage grouse).

As noted above, ecosystem services include cultural values. While broad–scale valuation of nonutilitar-

ian or nonuse values of U.S. rangelands are not available, research by Torell, Rimbey, Ramirez and McCollum (2005) provides some insight into how individual ranch sales prices reflect the values of rangeland aesthetics. These authors found that ranch location, terrain, elevation, and scenic views have a greater influence on ranch value than livestock income earnings obtained from the land. Ranch buyers appear willing to pay for desirable quality–of–life ranch attributes—many of which are a function of the natural environment.

In recent years, efforts have been made to examine the impacts of shrub control treatments on ecosystem services other than provisioning. However, the growing appreciation of nonprovisioning rangeland ecosystem services has not been matched by rigorous long–term quantification or valuation of the services (Herrick, Schuman and Rango, 2006). As noted above, woody plant invasion of rangelands reduces livestock carrying capacity. Thus, rangeland managers generally have an interest in controlling or reducing shrub encroachment. However, the costs of shrub control treatments usually exceed the livestock producers' benefits attained from increased forage production (Lee, Conner, Mjelde, Richardson and Stuth, 2001). The response of federal and state governments has been publicly funded shrub control programs, which usually pay for 50–85% of the cost of the treatments.

Torell, McDaniel and Ochoa (2005) have noted that if brush control projects are to be profitable expenditures of public funds then the unmeasured benefits of ecosystem services to nonlivestock entities must exceed the state, county, or federal subsidies necessary to induce livestock producers' participation in brush control programs. Thus, if the programs and actions of the land management agencies accurately reflect social priorities, then public funds spent on the cost–share payments may provide some sense of the social value of nonprovisioning ecosystem services enhancement on rangelands. Skeptics, however, will counter that land management agencies' budgets and spending priorities most often reflect political and bureaucratic objectives. While the use of public expenditures on brush control as a surrogate measure of the value of ecosystem services is problematic, it does provide some insight into the value society (reflected in the political process and agency decisionmaking) places on rangelands. However, it is currently unknown whether these expenditures are reflections of society's willingness to pay for rangeland ecosystem services, indications of nonmarket valuation (e.g., rangeland option, preservation, or existence values, etc.), or the perceived benefits arising from recreational opportunities such as hunting or bird watching.

Government land management agencies are increasingly justifying brush control efforts on the basis of rangeland health and improved rangeland condition, with both concepts encompassing the broadest possible array of ecosystem services (Olson, Hansen, Whitson and Johnson, 1994). Perceived benefits of brush control include ecological restoration and stabilization, enhanced biodiversity, improved wildlife habitat, aesthetic improvements, increased carbon sequestration, reduced wind–caused soil erosion, and increased off–site water yields. The commonly heard argument regarding water yield on rangelands is that more water will be available for run off and/or deep drainage if there is more grass and fewer shrubs; however, potential increases in water yields resulting from brush control are highly variable, unpredictable, and may be unrealistic (Wilcox, 2002; Wilcox and Thurow, 2006). The value of wildlife habitat has been reflected in higher ranch values (Torell, Rimbey, Ramirez and McCollum, 2005), conservation easement values (Knight and Johnson–Nistler, 2004) and in fee–hunting opportunities (Sorg and Loomis, 1985). The research results likely reflect some combination of both intrinsic and market wildlife values in selected locations, although it is difficult to separate the two values.

While past research provides some insight into specific ecosystem services from specific rangelands, quantification and valuation of ecological restoration, stabilization, and biodiversity in the aggregate and at a broad–scale remain elusive. Furthermore, ecosystem and biodiversity trade–offs between woody species, grasses, and associated wildlife species can exist (Connelly, Schroeder, Sands and Braun, 2000), and both woody and grassland plants sequester carbon (Havstad et al., 2007)

As noted above, cultural ecosystem values include educational, aesthetic, spiritual, and recreational opportunities. Western U.S. rangelands are the legendary wide–open spaces of American history and mythology (National Research Council, 1994); as a result they are settings for two–stage ecosystems services processes. First, rangelands provide forage; secondarily, the process of herding and managing the forage–consuming livestock appears to have high cultural and social value for many Americans. Placing a value on this "cattle culture" would be very difficult; however, it is possible that some sense of the magnitude of cultural values of western rangelands could be obtained through estimating the extent to which many ranching operations are subsidized by nonranch incomes. Gentner and Tanaka (2002) found that half of western public land ranchers earn less than 22% of their total income from ranching, that a ranch business "profit motivation" is a relatively low–ranked objective for all types of ranchers, and that public land ranchers are strongly motivated to be in ranching for tradition, family, and lifestyle reasons (i.e.,

cultural objectives). Pope (1987) concluded that "romance, recreation, the achievement of a desired social status, or simply the maintenance of a family tradition" are the primary motives for many western U.S. cattle producers.

The multiple roles of livestock in traditional societies have long been recognized by anthropologists, human ecologists, and other social scientists. In these societies, livestock are mobile stores of wealth and status. And even though the United States has a very advanced economy, livestock continue to be viewed as "banks–on–the–hoof" by many producers (Eastman, Raish and McSweeney, 2000). For many ranchers, cattle and the rangelands used to produce them are investments, savings, and financial safe–havens. Cattle provide emergency funds, and are also a stable supply of high quality meat for family consumption. Similar to their counterparts in traditional societies, western U.S. rangeland cattle production is a source of identity and a sociocultural touchstone. However, the fact that this source of identity often is derived from public domain rangelands continues to be a source of controversy and competing strong opinions. The middle–ground of western public rangeland use policy opinion holds that these lands can be sustainably managed for multiple uses (and multiple ecosystem services)—including livestock grazing (Brown and McDonald, 1995).

In Summary

Goods and services have value to humans because they provide utility and because they are scarce. Realistically, western U.S. rangelands are so expansive and so remote to the citizenry at large that attempting to infer broad–scale ecosystem values from small, localized studies will fall victim to the fallacy of composition. If broad–scale rangeland ecosystem services are valued at the margin, the values of those services are likely to be quite small.

Rangeland "restoration," primarily through brush control, continues to be a priority for federal land management agencies in the West. For example, through Restore New Mexico, the BLM is seeking to enhance wildlife, allow reintroduction of native wildlife species, improve watersheds, reverse the expansion of invasive plant species, and protect outdoor values (USDA–BLM–NMSO, 2007). Previous research would lead to the tentative conclusion that the value of increased provisioning through forage production resulting from landscape restoration is very likely lower than the costs of restoration. While it is possible that the sociocultural and intrinsic ecosystem values of landscape restoration in the region are high enough to justify public expenditures on the federally–funded effort, these values have not been quantified. Thus, the sociocultural and intrinsic ecosystem values rationale appears to be the justification for an ecosystems management policy which is likely to defy rigorous economic analysis now and in the future.

For More Information

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Rhonda Skaggs is Professor (rskaggs@nmsu.edu), Department of Agricultural Economics and Agricultural Business, New Mexico State University, Las Cruces, N.M.