Rangeland Degradation and Restoration in the "Desert Seas": Social and Economic Drivers of Ecological Change Between the Sky Islands

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Abstract—*The relative importance of different factors in driving ecological change in the valleys of southeastern Arizona and southwestern New Mexico has been debated for decades. Clearly, both anthropogenic and natural drivers have played roles: the focus should be on their interactions over time. I suggest that historically, debt and government policies interacted with periodic drought to cause degradation related to livestock. More recently, however, different interactions have emerged. Climate dominates over livestock because stocking rates have declined to relatively low levels, and the distribution of homes and conservation resources now determines where fire and other tools are employed for rangeland remediation.*

Introduction

Degradation of semiarid grasslands in the "desert seas" of the Madrean Archipelago is a well-established fact. In the most recent of many assessments, Gori and Enquist (2003) found that significant shrub encroachment has occurred on 3.5 million ha (84.1%) of historic grasslands in the Arizona and New Mexico portion of the Apache Highlands Ecoregion. In addition, most of the region's major floodplains have been incised by arroyos, beginning in the late nineteenth and early twentieth centuries, with pronounced effects on hydrology, riparian vegetation, and disturbance regimes (Bryan 1928, 1940; Cooke and Reeves 1976; Hastings 1959). A variety of techniques for reversing these changes have been attempted over the past century, but most have not succeeded on any long-term or large-scale basis (Roundy and Biedenbender 1995).

Much scholarly work has turned on the seemingly simple but effectively unanswerable question of whether or not human activities caused degradation. The list of potential culprits is long: livestock grazing, agricultural clearing, irrigation, fire suppression, timber cutting for mining and firewood, installation of railroad embankments and roads, and introduction of non-native flora (Bahre 1991, 1998; Cooke and Reeves 1976; Dobyns 1981; Humphrey 1958). That many of these activities began or peaked at about the time when degradation commenced has strengthened the case for anthropogenic causality. On the other hand, climatic factors remain difficult to exclude as drivers of ecological change (Hastings and Turner 1965; Turner and others 2003). The extraordinary rains of 1905, for example, might have cut arroyos in floodplains regardless of human activities. Similarly, the droughts of the 1890s, 1920s, and 1950s might have decimated perennial grass populations, and increased winter precipitation such as occurred during 1975-1995 might have encouraged shrub dominance, regardless of livestock effects (Curtin and Brown 2001; Herbel and Gibbens 1996).

Clearly the dichotomous theorizing of degradation as either human caused or not has reached the limits of its usefulness. It issues from the same philosophical tradition as equilibrium ecological theory, and it generally relies on a similar set of assumptions: that nature is self-equilibrating in the absence of human disturbance; that removal of a human disturbance will result in reversion to pre-disturbance conditions; that humans and history are separate from or outside of a timeless nature (Zimmerer 2000). These are flawed assumptions, for reasons both metaphysical and ecological. Rather than seek a single cause, or type of cause, of degradation, we should ask how multiple drivers have interacted over time, recognizing that impacts may be interactive, non-linear, and effectively irreversible. Whether degradation could have been prevented is a worthy question for scholarship, but it may have little practical bearing on what should be done to remedy the damage now.

A Historical Approach to Grassland Degradation

The interaction of human and natural drivers of grassland change in the Southwest must be studied historically. Evidence from around the region suggests that the ecological effects and relative importance of different drivers have changed over time. Consequently, the relative importance of different land management options has also changed. Here, I focus on the social and economic drivers determining the interactive effects of climate, livestock grazing, and fire.

Climate

The relevant feature of Southwestern climate, for present purposes, is the high variability of precipitation over space and time. Alternating periods of wet and dry conditions produce highly variable aboveground net primary production (ANPP) and recurrent ideal conditions for fire: large amounts of extremely dry fuels during periods of high temperatures and frequent lightning (McPherson 1995; McPherson and Weltzin 2000). Generally speaking, the region's flora and fauna are adapted to these biophysical circumstances, but the same cannot be said for human activities and institutions over the past 150 years.

Debt, Drought, and Overgrazing

Managing livestock grazing systems sustainably requires matching forage demand and supply, especially in response to drought. Natural grazing systems have built-in mechanisms to limit herbivore demand in response to low forage production (outmigration, mortality, reduced fecundity). But in the Southwest, several factors converged to interrupt this negative feedback mechanism for most of the twentieth century.

First, markets for credit and livestock were national in scale and overheated by speculation. After the Civil War, lenders and investors had strong incentives to send their capital West, where interest rates were high and opportunities apparently boundless (Atherton 1961; Frink and others 1956; Graham 1960). The cattle industry of the time was more dependent on credit than any other sector of the booming Western economy (White 1991). When forage gave out at one location, indebted livestock owners chose to move rather than sell in a sagging market, because liquidating at low prices was tantamount to defaulting (Abruzzi 1995). Arizona and New Mexico were among the last areas to experience the Cattle Boom, and the livestock they received were already refugees from adverse conditions elsewhere in the West (Wagoner 1952, 1961). When severe drought struck the Southwest in 1891-1893, there was no place left to go—the frontier had closed (Bahre and Shelton 1996).

Second, there were other obstacles to rapid destocking in the face of drought. One was perceptual: Rainfall was relatively high during the 1880s, when large-scale ranching took off in the region, so early ranchers were prone to stock at levels that would prove unsustainable when the rains failed (Bahre and Shelton 1996; Hadley and Sheridan 1995). Most were probably unfamiliar with such highly variable precipitation. Another obstacle was structural: The rapidly consolidating and industrializing meat processing sector began refusing to buy older cows in the 1890s (Wagoner 1952). This left ranchers who sought to destock with no economical way of doing so.

Third, government policies rewarded aggressive stocking as a means to control land. The public domain was an open access free-for-all, and "use it or lose it" was the prevailing ethic of the range. Free land was a major part of the extraordinary profitability of livestock production early in the Cattle Boom, but it became an equally significant threat to profitability once the frontier was closed (Frink and others 1956).

Unfortunately, the reforms enacted in the early 20th century to tame the excesses of the boom addressed only the issue of open access, not the question of temporal variability in ANPP. Exclusive leasehold to fenced allotments was implemented on National Forests after 1905, on State lands after 1912, and on the remaining public domain after 1934. Ranchers and their financial backers sought to capitalize leases, and agencies sought an objective basis for setting lease fees. All sides thus shared a common interest in assigning relatively fixed "carrying capacities" to allotments to facilitate credit and administration (Sayre and Fernandez-Gimenez 2003; Sayre 2003). The resulting system effectively institutionalized inflexible stocking.

In theory, carrying capacity estimates accounted for dry years and allowed for recovery during wetter years, assuming a moderate level of resilience (Wooton 1916). It is unknown, however, how closely actual stocking matched official capacity estimates, especially on State and BLM lands where enforcement was minimal. One study, conducted in the late 1950s and early 1960s, inadvertently learned that actual stocking on these lands was roughly double official allowed rates (Martin and Jefferies 1966). This may have reflected another bubble, inflated by cheap credit and high cattle prices during the period of post-war prosperity (Sayre 2002). Or it may have been the norm for decades. The available evidence is too meager to judge one way or another, although the larger pattern shows a steady decline in stocking over the twentieth century. Today's rates are less than half—in some cases less than one-fifth—of estimated stocking at the height of the cattle boom (Fredrickson and others 1998; Hadley 2001; Sayre 2000).

There is even less available evidence bearing on the most important question: To what extent did ranchers vary their stocking rates over time, as rainfall and ANPP rose and fell? Prices typically declined during drought, and many ranchers had invested heavily in the genetic make-up of their herds. Cow-calf production became the dominant form of ranching in the region by about 1930 (Wagoner 1952), so destocking required selling a capital asset: mother cows. Anecdotal evidence indicates that most ranchers chose to purchase (or grow) supplementary feed such as alfalfa hay, rather than sell their stock. Especially in combination with high debt loads, these factors discouraged destocking.

Land management agencies may also have had an incentive to keep stocking rates stable despite variable ANPP: fire suppression. Fire risks were highest during drought, and livestock grazing was an economical way to reduce the quantity and continuity of fine fuels across large, often remote areas. The political pressure to prevent and suppress wildfires generally outweighed other concerns in the U.S. Forest Service, which dominated fire policy and management not only on the National Forests but throughout the West. This may have prompted officials to turn a blind eye to grazing impacts that would otherwise have warranted action (Leopold 1924; Pyne 1982; Rowley 1985).

In summary, producer debt and government policy encouraged high stocking rates in the late nineteenth and early twentieth centuries. Reforms did nothing to encourage flexible stocking rates, and overgrazing became a routine consequence of drought conditions. One long-term consequence, intended or not, was large-scale suppression of fire. This led, in turn, to encroachment of woody plants into formerly grass-dominated areas, such that in many areas fire has now become either impossible (for lack of continuous fine fuels, mainly at lower elevations) or potentially catastrophic (due to continuous, highly flammable woody fuels, mainly at higher elevations).

Fragmentation, Fire, and Remediation

The interactions of social and economic processes with grasslands, climate, and fire in the Southwest have change fundamentally in the past 30 years or so. Livestock ranching is no longer the highest economic use of rangelands in the region (Workman 1986), and private ranch lands are steadily being converted to residential and recreational land uses (Sullins and others 2002). On the many ranches that remain, stocking rates are much lower than in the past, and ranchers appear to be more proactive in destocking during drought, if only because purchasing supplementary feed has become prohibitively expensive.

Gori and Enquist (2003) concluded that more than half of the grasslands overtaken by shrubs in the past 125 years have crossed an ecological threshold, such that even complete exclusion of livestock is unlikely to restore pre-settlement plant communities or fire regimes. Approximately 1.4 million ha does have potential for restoration through the use of fire, however. If the preceding analysis is correct, restoring fire to these lands is of the highest conservation importance, significantly higher than exacting further reductions in stocking rates (McPherson and Weltzin 2000).

Although many producer, environmental, and academic groups now support the use of fire as a management tool, the vast majority of wildfires are still suppressed, and prescribed fires remain few in number and generally small in size. What social and economic factors are enabling fire restoration where it is occurring, and what factors are compelling continued suppression elsewhere?

Certain conditions appear common to most sites where fire restoration is occurring. First, private landowners—either ranchers or environmental groups—are usually leading the effort to restore fire, even when the land being burned is public. Second, the sites are remote from concentrations of houses. This is not surprising, given the policy of the State Land Department to suppress all fires, and prohibit prescribed fires, within five miles of human inhabitations. Unless means are found to make houses and fires compatible, it is clear that conversion of even relatively small areas to residential uses has the potential to effectively eliminate fire as an available conservation tool in Southwestern grasslands and shrublands.

It is still the case that livestock grazing can remove the fine fuels needed to carry fires, especially in areas of mixed shrub-grass vegetation. On ranches where grazing continues, livestock exclusion is typically necessary for a period of one to two years to accumulate fuel prior to burning and for one to two years afterwards to allow recovery of grasses. Permanent livestock exclusion is not necessary, however, to achieve what is believed to be the natural fire return interval of 8-12 years (Kaib 1998).

Conclusion

Degradation and conservation of the “desert seas” of the Madrean Archipelago result from the interaction of natural and human drivers over time. Historic degradation due to livestock grazing reflected a mismatch between highly variable forage production and fixed demand. As a consequence of this mismatch and government fire suppression policy, fire was not a significant disturbance agent in the region during the twentieth century. This caused woody species to become sufficiently dominant that at present, fires either cannot occur or can only occur through active efforts to restore them. Such efforts cannot take place where significant numbers of houses have been built, however.

Although the interaction of livestock and drought triggered grassland degradation in the past, today the process is self-perpetuating and unlikely to be stopped or reversed by livestock exclusion alone. Removal of livestock grazing from State and Federal lands is more likely, in fact, to prevent fire restoration by triggering residential development of associated private lands. Most of the land in the desert seas is not Federally owned and has little or no protection from subdivision and development (Gori and Enquist 2003). Even protected areas may be disallowed from burning in the future if houses are built on adjacent private or State lands. If desert grasslands are to be preserved or restored, then, significant fragmentation and residential development will have to be prevented. This will require active cooperation with and among rural private landowners, especially ranchers, whose interest in grassland conservation is more direct than anyone else’s.

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