Ecological Effects of Ranching: A Six-Point Critique

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Ranching is the dominant land use in much of the American West. Although a copious literature has examined the effects of various grazing practices on native ecosystems, we present here the idea that ranching has important impacts on the land independent of those caused by grazing itself. If biological conservation is to be successful on the western grasslands and shrublands, ranchers must be central to any plan. Focusing on the Great Plains of the United States, and on Wyoming in particular, we raise six points of concern that must be addressed before we can hope to restore or maintain native ecosystems on the range.

Keywords: biodiversity, grazing, ranching, range management

Western rangeland grazing has been a much-studied and controversial subject for most of the last century. But most papers on the ecological effects of livestock on the rangeland ecosystem, whether critical or supportive of the practice, neglect the central question: How different are rangelands now from the way they were before ranching? In other words, does ranching have long-term ecological impacts, and can we ever hope to see the range as it was? We discuss the extant literature on grazing briefly, because this is where answers to these questions are most often sought. However, this literature often neglects additional consequences of ranching. Therefore, we raise six points related to ranching practice that have been either conspicuously ignored or greatly downplayed. We hope this synthesis will stimulate discussion among both ecologists and the burgeoning ranks of conservation ranchers.

There is an important reason for considering this subject now. The socioeconomics of the "New West" have led some organizations to view ranching as an important alternative to the subdivision of landscapes for development (hence the slogan "Cows, not condos"). Furthermore, ranching, portrayed as a benign pastoral pursuit, is believed to be compatible with the long-term maintenance of biodiversity (Redford and Richter 1999, Budd 2000). It is possible that both of these arguments have merit. Today, growing numbers of ranchers practice "Holistic Management" (Savory 1988), carefully managing stocking levels and moving animals to more closely mimic historic patterns of bison grazing. Their goal is to maintain ranched lands that are indistinguishable from unranched lands with respect to biodiversity and ecological function. But is this goal possible? In this article, we ask readers to consider all of ranching's effects on the range and to judge whether this goal can be met.

In the six points that follow, we raise ecological concerns based on current ranch practices. We differentiate between practices that might be mitigated and those so integral to livestock production that they are probably impossible to mitigate. Although ranching is a diverse practice, ranchers and range managers are, in general, a conservative group, and with notable exceptions (e.g., Bock et al. 1993, Popper and Popper 1994), few authors seem willing to see beyond the way things are now. We question the ecological sustainability of current ranching practices and ask that the potential of ranching as a conservation tool be considered critically.

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The Great Plains of North America have been grazed by ungulates for millennia. A substantial literature exists on the ecological effects of livestock grazing (Kauffman and Krueger 1984, Belsky 1986, Milchunas and Lauenroth 1993, Belsky et al. 1999, Jones 2000), some of it addressing differences between native and nonnative grazers (e.g., Oesterheld et al. 1992, Hartnett et al. 1997). Many papers comparing grazed with ungrazed areas show subtle or ambiguous results (e.g., Hayward et al. 1997, Milchunas et al. 1998, Stohlgren et al. 1999a), perhaps because the experiments, in some cases, were performed in relatively small exclosures (Bock et al. 1993, Stohlgren et al. 1999b).

Opinion seems divided on whether grazing is good or bad for range plants (Belsky 1986, Milchunas et al. 1988, Vavra et al. 1994, Belsky et al. 1999) or for whole ecosystems (Fleischner 1994, Frank et al. 1998). Studies from the Great Plains and around the world have shown that properly managed grazing can be an effective tool in fighting noxious weeds (Olsen 1999), providing needed habitat for early successional species (Pykälä 2000) and improving range conditions generally (Hay and Kicklighter 2001). On the other hand, a recent summary article concluded, "In many regions of the world, grazing has reduced the density and biomass of many plant and animal species, reduced biodiversity, aided in the spread of exotic species and disease, altered ecological succession and landscape heterogeneity, altered nutrient cycles and distribution, accelerated erosion, and diminished both the productivity and land use options for future generations" (Kauffman and Pyke 2001, p. 34).

We know of no studies explicitly comparing biodiversity and ecosystem function in ranched and unranched lands. This dearth of research motivated Bock and colleagues (1993) to propose large-scale experiments. They advocated setting up numerous large (100- to 1000-hectare) grazing exclosures on federal lands to better test the full effects of grazing on native plant and animal diversity. We strongly support this suggestion, but even such large-scale studies would not account for the additional effects of ranching beyond the herbivory of ungulates. There are six impacts associated with ranching that are likely to have strong effects on native biodiversity. Although these impacts may seem obvious, they have rarely been considered in the scholarly literature.

"Problem" animals

Operating on slim margins, many ranchers face economic ruin from loss of stock. Predators are an obvious hazard. In mesic climates, herders learned they could fence their animals for protection. But in dry regions like the Great Plains, the animals could not find enough food or water in fenced lots. The use of open range was an economic alternative, but it left the livestock vulnerable to losses from predators. History has documented that, in response to these losses, humans extirpated nearly all the top carnivores on western rangelands (Wilcove 1999). Today we think of grizzly bears and wolves as forest dwellers, but Lewis and Clark encountered them on the plains (Cutright 1969), where, according to contemporary descriptions, they remained common until the mid-19th century (Wilcove 1999). If top-down regulation by predators is important in structuring ecosystems, as some suggest (Soulé and Terborgh 1999, Terborgh et al. 1999), that mechanism no longer exists on Wyoming rangelands.

Today, predators remain detested and feared on the range (Kellert 1985). The commissioners of Fremont County, Wyoming, for example, fearing the spread of animals reintroduced to Yellowstone National Park, passed a unanimous resolution prohibiting the presence, introduction, or reintroduction of grizzly bears, wolves, or other "unacceptable species" within the county (see *Casper Star-Tribune,* 12 March 2002, for example). Nor are predators the only animals perceived as threats to ranching. Black-tailed prairie dogs, occupying 2 to 3 percent of their former range, are considered worthy of threatened status by the US Fish and Wildlife Service (USFWS 2000), yet they continue to be poisoned and shot by ranchers and by government officials working on the ranchers' behalf. Although many studies dispute the need for wholesale eradication (Davitt et al. 1996), a well-entrenched mind-set perpetuates it, a point substantiated by studies (e.g., Lybecker et al. 2002) and by our personal observations.

The persecution of "problem animals" in the West continues. On Wyoming rangelands, ground squirrels, pocket gophers, snakes, raptors, and many other species are destroyed at the whim of individuals. In some communities there are organized hunts in which groups purposely kill coyotes or other target animals in the belief that they are performing a public service (Andrea Lococo, The Fund for Animals, Jackson, WY, personal communication, April 2002). The extent of shooting by individuals is unknown and most likely unknowable. This subject is apparently taboo in the range management literature—we have never seen it mentioned. What sorts of biological effects must the absence of carnivores and the continuing destruction of other animal species have on the rangeland ecosystem, especially when considered over the long term and over many species? Such human alterations may serve the ranchers' short-term interests in some cases. But over the long run they cannot help but alter the entire rangeland, perhaps—and, in the light of current ecological knowledge, most likely—to the detriment of the ranchers and everyone else.

Affirmative statements from national stock growers' associations in opposition to shooting animals could help ameliorate the situation, but there is a long way to go in changing people's mind-sets. Reintroduction of predators, protection of nongame wildlife, and environmental education at the community level could all help in restoring rangeland ecosystems. We consider the issue of "problem animals" one that is amenable to human remedy, but only if it is acknowledged and openly discussed.

Truncation of the food web

When Lewis and Clark crossed the West in 1804–1806, they saw the bloated carcasses of hundreds of dead bison lying on sandbars in the Missouri River. These dead animals provided feasts for a coterie of decomposers and scavengers that included wolves, wolverines, eagles, vultures, bears, and many other animals (Cutright 1969). The vast numbers of bison that died each year on the prairies lay where they fell, constituting a central node in the food web that was critical to these scavengers and decomposers (Dunne et al. 2002). All of the bison, scavengers, and decomposers were recycled back into the system (Knapp et al. 1999, Towne 2000), supporting a large biomass of other organisms in turn.

Today the areas where the bison ranged are dominated by cattle, which are consumed by a single species (humans) hundreds or thousands of miles removed from their ecosystem of origin. We have replaced an ecosystem in which everything was recycled with a human-dominated system in which it is not. Significant parts of the nutrient pool are removed from the rangelands and relocated to wastewater treatment plants and cemeteries. The death rate of cattle on ranchlands is tightly managed and is typically less than 10 percent. Not only do ranchers keep mortality to a minimum (as an economic necessity), but government agencies expressly forbid them to leave carcasses on the ground, where they might attract bears or other problem animals. The diverse strands of the food web formerly occupied by decomposers and scavengers dependent on large animal carcasses—wolves, carrion beetles, ants, vultures, and countless others—are not only missing, their absence is unmentioned. The decomposers themselves, which were also recycled in situ, no longer contribute to the ecosystem. The familiar lion kill on the Serengeti had a Wyoming equivalent that no longer exists.

National parks, where large numbers of bison and elk decompose naturally on the ground, might have different numbers or species of decomposers and scavengers (Sikes 1994). To test this question, we might compare areas of Yellowstone National Park, for example, with areas outside it. Are there species missing? The California condor *(Gymnogyps californianus),* for example, was once found across America (Snyder and Schmitt 2002). The American burying beetle *(Nicrophorus americanus),* known chiefly from the eastern and central United States, is today on the US endangered species list. Any number of other species may already have become extinct without notice.

With respect to carbon biomass, ranching is an extractive industry; but biomass export is only one part of the problem of truncation. Removal of this vast biomass results in less material to be recycled and consequently fewer organisms to recycle it. Whether there has also been a loss of species is a question that begs an answer. Here, as throughout our discussion of the six points, one of our main goals is to convince range scientists to study this issue. It seems to us that restoring some level of natural recycling is key to rangeland ecology, but how this might be achieved remains problematic for now.

Fencing, roads, and fragmentation

In the 19th century, when homesteaders and open-range factions fought what history books call "the Range Wars," the question was whether the range would be free and open or fenced into pastures. Today, the West is a dense grid of roads, fence lines, power lines, and human developments (Forman 2000). Ranching's contribution to this development has been substantial (although mining and energy production have also been important); ranching occupies the largest part of the otherwise uninhabited western range. Whether paid for by the rancher or ordered by an agency, fences are used to separate management zones. The result is a landscape mosaic in which separate pastures are the tools of grazing management.

Habitat fragmentation is known to cause a constellation of often subtle effects (Saunders et al. 1991, Sanderson and Harris 1999). Although most livestock fencing is porous to the movement of native species, it is known to cause mortality in native ungulates caught on fences and alterations to large-scale movements of game animals. Fences, moreover, are but one reflection of land ownership patterns that utterly transform the landscape. Weeds follow roads (see below), and roads have other effects as well, including roadkills (Hobbs and Huenneke 1992), provision of perches and foraging routes for predators (Knight and Kawashima 1993), and alteration of animal movement patterns (Diffendorfer et al. 1995). The mass movements of millions of bison could not occur today, not because of the physical barriers created by fences but because of the property boundaries they represent. A substantial bibliography of these effects appeared in a special issue of *Conservation Biology* (2000: 14 [1]). More research is needed on the causes, effects, and best mitigation measures for habitat fragmentation on the range. Fortunately, fences and roads are human constructions capable of being changed if people agree to do so.

Exotic weeds and the poisons used to control them

Weeds are the bane of range managers today (DiTomaso 2000). Not only do exotics flourish in disturbed areas (Mack 1981), but livestock producers and the agencies that support them have historically seeded large areas with nonnative species intended to improve the range (Schwendiman 1956). As a result, US western rangelands contain significant areas of disturbed, infested, or ruderal vegetation that were caused directly or indirectly by livestock production. We know that weeds follow human presence in most areas, so ranching is not solely responsible for the invasion. Nonetheless, the ranchers' focus on economic productivity makes preservation of native grasses a provisional goal, embraced when it increases profits and abandoned when it does not (Belsky and Gelbard 2000). Stymied land managers have had little success fighting Wyoming's plagues of leafy spurge, cheatgrass, and toadflax (Cousens and Mortimer 1995). Although there are time-of-year and species-specific strategies that can be used to put livestock to work eating weeds (Olsen 1999), victories are few, and each year the acreage of infested land expands (Baker 1986).

As if the exotics themselves were not problematic enough, the methods used to fight them compound the assault on our native biodiversity. Weed control, whether chemical, physical, cultural, or biological, has a limited history of success (Mack et al. 2000) and creates its own environmental problems. Herbicide use is particularly widespread, and most herbicides affect a wide range of species (Sheley and Petroff 1999, Tu et al. 2001). Moreover, government agencies' knowledge of the chemicals used and their amounts are vague. Neither the Wyoming Department of Agriculture nor the US Department of Agriculture's National Agricultural Statistics Service Web sites provide a clear tally of amounts, although thousands of acres are reported as treated with thousands of pounds of herbicides.

Although ranch managers may see spraying as a successful way to control weeds, the chemicals create other widespread if subtle effects, such as the poisoning of stream invertebrates and bioaccumulation in the fish that eat them (Howarth 1991). Since *Silent Spring* (Carson 1962), people have been aware of the negative biological effects of chemicals. But on the range, as elsewhere, we can only guess at the total, incremental, long-term effects of these poisons on the environment. Both weeds and herbicides are truly Pandora's boxes opened and now virtually impossible to close.

Alteration of fire regimes

Fire is an ancient process, playing a crucial role in soil nutrient cycling, succession, and the persistence of particular species (Noss and Cooperrider 1994, Hartnett et al. 1996, Pyne 1997). Whether started by lightning or set by Native Americans, fire played a much larger role before this century, when its suppression became widespread (Krech 1999). Although the landscape we see today may be visually similar to what the early European explorers saw (Knight 1994), a number of photographic histories show how fire created openings and diversity in landscapes that are today more homogeneous and have denser forest patches (Progulske 1974, Meagher and Houston 1998). The alteration of rangelands by human fire suppression is exacerbated by the introduction of nonnative plants. The widespread occurrence of cheatgrass, for example, affects the spread of fire between shrubs, often resulting in fires that burn hotter and over a greater extent than would be expected under natural conditions (Young and Allen 1997).

Fire has an important role on the range, both as a way of preserving biodiversity and as a key ecosystem process (Pyne 1997). Allowing a role for natural fire on ranches is difficult. Piecemeal burning of individual pastures may not, even in the long run, replicate the natural fire processes of western ecosystems that once proceeded on a landscape scale. Fire is a management technology at the edge of human control, and the general public and many land managers fear it, as demonstrated by reactions to the Yellowstone fires of 1988 and more recent western fires. Ranch economics also play an important role in undermining natural fire regimes, as even the most enlightened manager will have trouble withholding sufficient land from production to allow for burning (and a season or two of recovery) on a meaningful scale.

How important has fire suppression been in changing community composition and affecting native biodiversity in Wyoming and on the shortgrass prairie in general? We don't know. Although fire ecologists have pieced together fairly detailed fire regimes and fire histories for some North American forests, little work has been done on rangelands (Chowns et al. 1998, Paysen et al. 2000). One recent study conducted in Nebraska's Niobrara Valley concluded that "fire is a key ecosystem process in grazing behavior in sand hill grasslands...and can significantly change the spatial distribution and landscape patterns of plant diversity" (Biondini and Steuter 1998, p. 71). Further studies on fire suppression are needed, particularly in the shortgrass prairie.

Impacts to water supplies and riparian areas

Two water-related factors are central to ranching in the arid West: provision of drinking water for livestock and irrigation of hay meadows for winter feed. It is well documented that the biota of small streams is negatively impacted by congregation of livestock and that irrigation has led to the conversion of native marshes, willow thickets, and wet meadows into ubiquitous hay meadows (Buckhouse et al. 1981, Marlow and Pogacnik 1985, Belsky et al. 1999). There is an extensive literature on grazing effects on riparian ecosystems, much of it contentious (e.g., Kauffman and Krueger 1984, Skovlin 1984, Larsen et al. 1998). Riparian grazing has various observable impacts on the entire ecosystem (Dobson 1973, Schulz and Leininger 1991, Dennis 1997), even when streams are not dewatered by withdrawals (Vavra et al. 1994, Belsky et al. 1999). Such impacts may be persistent; recent work has shown that past mismanagement may significantly undermine the ability to restore riparian communities (Harding et al. 1998).

Because of harsh winter weather, the provision of supplemental winter feed is important to successful western ranching. In all but the best years, winter hay is a necessity. In the early settlement of Wyoming, ranchers quickly occupied and converted the lands around virtually every significant watercourse from riparian willow, sedge, and shrub into hay meadows (Dorn 1986, Larson 1990). These wetlands once were critical oases of biodiversity in the harsh, dry environments of the plains. Native wet meadows may contain willow *(Salix),* alder *(Alnus),* cottonwood *(Populus),* and diverse forbs; hay meadows replace this richness with one or two seeded grasses. Bird species decline or disappear when these habitats are lost, including Lincoln's sparrow *(Melospiza lincolnii)* and Wilson's warbler *(Wilsonia pusilla)* (Schulz and Leininger 1991, Cicero 1997). Many studies of livestock grazing document its impacts on ranch riparian communities, but without specifically separating the grazing from the practice of irrigating hay meadows (e.g., Kauffman and Krueger 1984, Schulz and Leininger 1991, Elmore and Kauffman 1994).

The ubiquity of hay meadows has resulted in a great reduction of willow, alder, cottonwood, and sedge wetlands along most Wyoming streams. Despite the many helpful mitigation projects carried out by responsible ranchers, there is no escaping the fact that water is scarce in the West. Even if the livestock are fenced to prevent riparian trampling, water must still be diverted for the animals, and sacrifice of willows for winter hay is still unavoidable. This is another major change that has altered the West but is now accepted as the status quo and rarely questioned. We see no easy way to mitigate this important negative impact on the ecosystem.

Conclusions

We know that Native Americans torched the prairies, strongly affecting native fauna for centuries (Krech 1999, Wilson 2002). Yet the diaries of Lewis and Clark describe a place of unimaginable beauty, of prairie grass, wildlife, and richness, which today seems like an image from a dream. Exactly how different is today's landscape? That is a question rangeland scientists should be working to answer. Ranching today occupies the largest area and is the dominant land use in the western prairie (Donahue 1999). Although many people view ranching as a relatively innocuous, pastoral pursuit and a historically valuable part of the Old West (Knight et al. 2002), our six points suggest that it is not ecologically benign.

Certainly there are better ways to ranch, and progressive ideas based on a fuller understanding of ranching's impacts should be encouraged in the ranching community (Dolan 1999). Savory's (1988) goal of mimicking natural processes, such as bison grazing and patterns of rest and rotation, is good as far as it goes. Perhaps manure or fertilizer could be used to enrich lands depauperated by the absence of bison carcasses. Fire managers could do what they can to promote a long-term view. Ranchers who value nature can, as we have seen, conserve natural ecosystems while staying in business, provided they consider the ecological effects of both grazing and ranching. The negative effects of ranching that can be mitigated should be mitigated. The negative effects that cannot be mitigated should be honestly acknowledged.

It is important that range scientists learn more about the differences between ranched lands and protected areas. Controlled experiments contrasting ecosystems on rangelands to national parks, wilderness areas, and wildlife refuges would help resolve the question posed at the beginning of this article: Are the ranched lands different? The system of large-scale grazing exclosures proposed by Bock and colleagues (1993) should be established and studied. Such scientific research could provide the knowledge necessary to help conserve as much of our ecological heritage as possible.

New kinds of experimental management could further this research. A "Buffalo Commons" (Popper and Popper 1994, Callenbach 1996) has been proposed as a way to restore ecosystems and a viable economy to parts of the western range. By removing fences and restoring bison, the Commons would allow restoration of large-scale ecological processes and could supplement the local economy through ecotourism. We believe one or more of the national grasslands should be devoted to such experiments, with adjacent landowners invited to join in. Such projects would provide valuable comparisons between conventionally ranched lands and unranched lands.

Above all, ranch managers and conservation biologists should consider the six points we have raised as they contemplate today's landscape. These points raise serious questions about whether conventional ranching is compatible with long-term biological conservation. To help enlightened ranchers better manage their lands and help public lands managers decide whether or not to allow grazing on the lands in their care, *all* the effects of ranching need to be considered.

Acknowledgments

This article has had the benefit of lively discussions with many academics, ranchers, conservation staffers, and agency personnel. We are especially indebted to Carl Bock, Bob Budd, Debra Donahue, Allison Jones, Rick Knight, William Lauenroth, Tony Malmberg, Gary Meffe, Phil Riddle, Tom Throop, and George Wuerthner, who represented many diverse views on the topic. We thank them all greatly for their suggestions.

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