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APPLICATION OF HERBIVORE OPTIMIZATION THEORY TO RANGELANDS OF THE WESTERN UNITED STATES[1]

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Abstract. The central assumption for management of range condition—that plant response to selective grazing drives changes in plant community structure—is only weakly supported by evidence from semi-arid rangelands. Most of the vegetation changes attributed to selective grazing can instead be explained through proper interpretation of grazing intensity. Specialized livestock grazing systems, which assume that selective seasonal grazing controls ecosystem function, work poorly on semi-arid rangelands when compared to simpler grazing methods based on managing grazing intensity. Compensatory growth has been well linked to ecosystem processes in highly productive and intensively managed pastures, but not on semi-arid rangelands.

Key words: grazing systems; livestock grazing; range management; selectivity; semi-arid rangelands.

Painter and Belsky (1993) use the debate over compensatory growth as the focus for discussion about the development of basic ecological research, its application to rangeland management, and its interpretation by the popular media. They suggest that the evidence for overcompensation is scanty and controversial and that results have been misapplied by managers and the popular press. I believe that ecologists and range managers have incorrectly generalized the function of grazing in range ecosystems by failing to recognize the distinctive role of herbivory in semi-arid rangelands.

Rangelands are a type of land that includes grasslands, savannas, and shrublands (Society for Range Management 1989). When grazed by livestock these lands are termed range. The unifying characteristic of rangelands is that primary productivity per hectare is typically lower than croplands or forest lands (Lewis 1969). Rangeland ecologists assume that the grazing process is an important control of ecosystem structure and function and have devoted considerable effort to understanding plant and animal response to herbivory. However, most of the research into plant–animal interactions has been conducted in intensively managed and highly productive tame pasture ecosystems (Heitschmidt and Stuth 1991), not rangelands.

USE AND MISUSE OF THE ECOLOGICAL RANGE CONDITION MODEL

When the range management profession developed, beginning just before World War I, its mission centered on protecting deteriorating rangelands from excessive use by livestock (Jardine and Anderson 1919). Early range ecologists developed an ecological condition model that assumed that selective grazing by livestock changed the relative fitness of plants, leading to changes in community structure. The model suggested that the processes of range deterioration due to overgrazing and range recovery following improved management paralleled the changes during secondary succession (Sampson 1917). Selective grazing of preferred plants and their resulting inability to out-compete less palatable species was assumed to be the main factor driving range deterioration and limiting range improvement (Ellison 1960).

It is now clear that various aspects of the ecological condition model and its explanation were invalid. First, the model linking range condition and succession, developed using tall-grass prairie examples (Dyksterhuis 1949), works fairly well in that productive ecosystem, but not in less productive grasslands (Hyder et al. 1975) or shrublands (Westoby et al. 1989). Changes in the California annual grassland and in the Intermountain sagebrush–grass rangeland ecosystems, for example, either are not well described by linear successional models (West 1988), or the range condition changes do not parallel successional changes (Laycock 1991), or both (Bartolome 1989). With longer-term observations of plant community change, rangeland ecologists have concluded that changes due to weather in these two ecosystems are far more important than those related to grazing (West et al. 1984, Heady et al. 1991).

IS SELECTIVITY IMPORTANT?

The factor of selective grazing has not been well linked to observed vegetation changes in any semi-arid rangeland system. Although, based on diet studies, herbivores are known to be selective, and they therefore must selectively remove plant biomass, the links to differential plant fitness for western rangelands remain

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weak (Ellison 1960, Bartolome and McClaran 1992). The observed changes in range condition supposedly related to changes in selective grazing all can be better explained simply by the effects of grazing intensity, without invoking selectivity at all. For example, in the California grassland, changes that mimic changes in range condition under grazing can be recreated simply by non-selective fall mowing (Bartolome et al. 1980, Heady et al. 1991). When grazing has been studied directly, the effects of selectivity do not show up as subsequent similar changes in vegetation composition (Bartolome and McClaran 1992). Likewise, for the sagebrush–grass type, the season of use and factors related to presumed selective grazing have little effect on composition (Laycock 1987, Bartolome et al. 1988). High grazing intensity affects plant growth and composition, but not through selectivity, and weather patterns dominate any grazing response (West 1988). In semi-arid rangeland environments differential plant response linked with selective grazing is simply not very important as a factor regulating the structure and function of the ecosystem.

Assuming that vegetation change and selective grazing are tightly linked, range managers have designed and implemented specialized grazing systems either to restore damaged range or reduce undesirable changes in community structure (Heady 1961). Range vegetation has often improved under these systems, but the independent effect of the grazing system is rarely known. The majority of grazing systems are designed around the presumed links between grazing and ecosystem function, are implemented, and then are judged to work if observed changes in vegetation are acceptable. This approach, which omits rigorous testing of the effects of the system as separate from changes in vegetation due to weather, effects of range improvements, and the effects of improved animal management in general, has led to the proliferation of marginally acceptable, yet suboptimal management practices (Drawe 1991). Complex grazing systems have been repeatedly proved of little value in the California grassland (Bartolome and McClaran 1992) where simple provision of adequate ungrazed residue in fall provides for optimal range forage production. In the sagebrush–grass type, where excessive grazing severely damaged native plants, specialized seasonal grazing systems were abandoned by a land management agency in favor of equally effective and simpler systems that simply control grazing intensity during the period of active growth (Bartolome 1984, Bartolome et al. 1988). Increasingly it appears that management of grazing on arid and semi-arid rangelands requires control of grazing intensity but not management based on selectivity.

Is Compensatory Growth Important?

Compensatory growth may be of considerable importance to the individual plant for its continued survival, but if not linked to higher-level ecosystem processes, compensation has little relevance to management or other application. Much of the evidence for overcompensation is from highly productive and intensively managed systems (Dyer et al. 1991) in which grazing plays a very different role than it does on most rangelands. The various studies examining plant response to grazing or to clipping need re-evaluation because there is no solid evidence for an ecosystem-level response to selective defoliation in semi-arid and arid rangeland systems. Establishment of better links of plant–animal interactions to system function may require better coordination between range managers, who manage ecosystems and communities, and ecologists, who usually experiment with individual plants and populations.

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