ACCOUNTING FOR SELECTIVE GRAZING IN THE STOCKING RATE DECISION

M.F. Quirk[1] and J.W. Stuth[2]

[1]Queensland Dept. of Primary Industries, Charters Towers Q 4820, Australia

[2] Dept. Rangeland Ecology & Mgmt, Texas A&M Univ., College Station, TX 77843, USA

ABSTRACT

We describe the development and use of a simple, generic method for predicting botanical composition of herbivore diets, thereby allowing resource managers to consider selective foraging when setting stocking rates. For a particular season and herbivore, we found that forage species fall into one of 3 selection categories: preferred (consistently selected for), undesirable (consistently selected against), and variable (inconsistent selection pattern). Our studies showed that, for most situations, dietary composition is adequately predicted from regression relationships with the field proportions of preferred and undesirable species. We demonstrate how this method can help address issues such as the conservation of preferred forage species and the effect of multispecies grazing on carrying capacity.

KEYWORDS

Stocking rate, selective grazing, diet, rangeland, decision support, multispecies grazing

INTRODUCTION

Exceeding the long-term safe stocking rate, or carrying capacity, is often implicated in the widespread deterioration of rangelands (eg, Tothill and Gillies, 1992; Miller et al., 1994). Vegetation response to grazing is largely a function of defoliation-induced changes in the competitive interactions between forage species (Briske, 1991). Thus, maintaining or attaining a particular botanical composition of rangeland must be based on controlling the level of defoliation of individual forage species. Commonly-used concepts such as stocking rate and grazing pressure are most often used to characterize animal demand on the total forage resource. However, all herbivores forage selectively and grazing pressure is not applied uniformly to all plants species.

A common approach to estimation of carrying capacity is based on proper use or safe utilization (Holechek et al., 1989; McKeon et al., 1990) which seeks to restrict the average degree of forage utilization to some critical level, usually between 25 and 50%. There are many variations to this approach (see Quirk, 1995), but all fail to adequately account for selective grazing and, therefore, may not ensure the safe use of preferred forage species. We describe the development and use of a simple, generic algorithm that predicts the botanical composition of the diet, thereby allowing calculation of animal demand for each plant species.

Patterns of use of forage species. Describing the pattern of forage use has traditionally been approached by comparing use and availability (Thomas and Taylor, 1990), with selective grazing indicated by disproportionate use of forage species. Numerous such assessments have been reported for many rangeland and pasture sites throughout the world. While such studies have undoubtedly contributed to more informed management in a heuristic sense, the site-specificity of such studies has limited extrapolation to other sites or times.

We have used the modified forage ratio of Jacobs (1974) to assess the selection patterns of cattle and goats grazing post oak (*Quercus stellata*) woodland in east central Texas (Quirk, 1995). We found that, for a particular season and herbivore, forage species fall into 1 of 3 selection categories:

* preferred = consistent selection for a particular forage species;
* undesirable = consistent selection against a forage species;
* variable = inconsistent selection pattern.

We found no evidence of switching of preference, ie., the selection category of a forage species did not change with either relative or absolute changes in species abundance. Importantly, we have applied the same analytical approach to data from other diet studies in completely different environments and found similar patterns of selectivity (Quirk, 1995). It therefore seems possible to allocate forage species to 1 of 3 selection categories for any combination of plant community, season and herbivore.

Predicting botanical composition of diets. Generic approaches to predicting botanical composition of diets (Rice et al., 1983) have often assumed a constancy of diet composition within each season. Such approaches do not adequately reflect the interaction between preference and availability that determines selectivity. Taking each of our selection categories (preferred, undesirable, and variable), we sought predictive relations between diet composition and field composition in the Texas data set described above. We found that predictability was much greater when composition was expressed on the basis of selection categories, rather than individual species within categories. Regression relationships explained c. 60% of variability, and relations were sometimes dependent on animal type, season, and, for the preferred category, on the relative availability of undesirable species (see Fig. 1). An algorithm was developed that predicted dietary composition as a function of the field proportions of preferred and undesirable species. Testing of this algorithm on independent data sets showed good agreement between predicted and observed dietary compositions except when field availability of preferred species was very low (Quirk, 1995).

Application of the diet-selection algorithm. Selection pressure on preferred species increases as they become less abundant (Fig. 1), thereby intensifying the cumulative threat to their persistence. Fig. 2 shows the relation between the contribution of preferred species (mainly the bunch grass, *Schizachyrium scoparium*) to forage yield in post oak woodland and "safe" stocking rate (defined as <30% use of preferred species). Conservation of such species when in low abundance may therefore require stocking rates that are commercially unacceptable. The diet-selection algorithm can assess such scenarios thereby helping to explain, for example, the local extinction of palatable forages from many rangelands (O'Connor, 1991).

Multispecies grazing can increase harvest efficiency from rangeland (Nolan and Connolly, 1977) but there is currently no easy way of determining the optimal mix of different animal species. We have incorporated the diet-selection algorithm into the decision-support system, POPMIX (Quirk and Stuth, 1996) which is designed to address issues such as the best mix of animal types and the effects of wildlife on carrying capacity. For example, we have shown that the carrying capacity of some plant communities within the subtropical thorn shrubland of south Texas increases linearly with increasing proportions of goats in the cattle-goat mix (Quirk and Stuth, 1996).

CONCLUSIONS

Selective grazing by domestic and wild herbivores has been widely recognised and studied. The functional nature of selectivity, its ultimate consequences for genetic fitness, and its proximate causes are well documented (Provenza, 1995). However, the impact of this knowledge on natural resource management is equivocal. We have used a more empirical approach to come up with a generic method of accounting for selective grazing. The logic of our diet-selection algorithm is consistent with theory and, moreover, provides a means for resource managers to consider selective foraging in the planning process.

REFERENCES

Briske, D.D. 1991. Developmental morphology and physiology of grasses. Pp. 85-108. *In:* R.K. Heitschmidt and J.W. Stuth (eds.),

Grazing management - an ecological perspective. Timber Press, Portland, Oregon.
Holechek, J.L., R.D. Peiper, and C.H. Herbel. 1989. Range management principles and practices. Prentice Hall Publication Company, Englewood Cliffs, New Jersey.
Jacobs, J. 1974. Quantitative measurement of food selection. Oecologia **14**: 413-417.
McKeon, G.M., K.A. Day, S.M. Howden, J.J. Mott, D.M. Orr, W.J. Scattini, and E.J. Weston. 1990. Northern Australian savannas: management for pastoral production. J of Biogeography **17**: 355-372.
Miller, R.F., T.J. Svejcar, and N.E. West. 1994. Implications of livestock grazing in the intermountain sagebrush region: plant composition. p. 101-146. *In:* M. Vavra, W.A. Laycock, and R.D. Pieper (eds.), Ecological implications of livestock herbivory in the west. Society for Range Management, Denver, Colorado.
Nolan, T., and J. Connolly. 1977. Mixed stocking by sheep and steers - a review. Herbage Abstracts **47**: 367-374.
O'Connor T.G. 1991. Local extinction of perennial grasslands. Amer. Naturalist **137**: 753-773.
Provenza, F.D. 1995. Postingestive feedback as an elementary determinant of food preference and intake in ruminants. J. Range Management **48**: 2-17.
Quirk, M.F. 1995. Field Testing and Enhancement of the Diet-Selection Algorithm of POPMIX: A Decision Support System for Multispecies Stocking of Rangeland. Ph.D. Dissertation. Texas A&M Univ, College Station, Texas.
Quirk, M.F. and Stuth J.W. 1996. POPMIX: A decision-support system for multispecies stocking of rangeland. Proc. 8th. Biennial Conf. Aust Rangeland Soc, Port Augusta, South Aust. In Press.
Ranching Systems Group. 1993. Grazing Land Applications User's Guide. Dept. of Rangeland Ecology and Management, Texas A&M Univ, College Station, Texas.
Rice, R.W., M.C. MacNeil, R.G. Jenkins, and L.J. Koong. 1983. Simulation of the herbage/animal interface of grazing lands. p. 475-488. In: W.K. Laurenroth, G.V. Skogerboe, and M. Flug (eds.), Analysis of ecological systems: state-of-the-art in ecological modelling. Elsevier, Amsterdam.
Thomas, D.L., and E.J. Taylor. 1990. Study designs and tests for comparing resource use and availability. J of Wildlife Management 54: 322-330.
Tothill, J.C. and C. Gillies. 1992. The pasture lands of northern Australia: their condition, productivity, and sustainability. Tropical Grassland Society of Australia, Brisbane, Australia.

Figure 1

Regression relationships between diet and field proportions for (a) the preferred species category and (b) the undesirable species category for cattle grazing post oak woodland in Texas. Note that the relationship for preferred species is also a function of the field proportion of undesirable species (field und %).

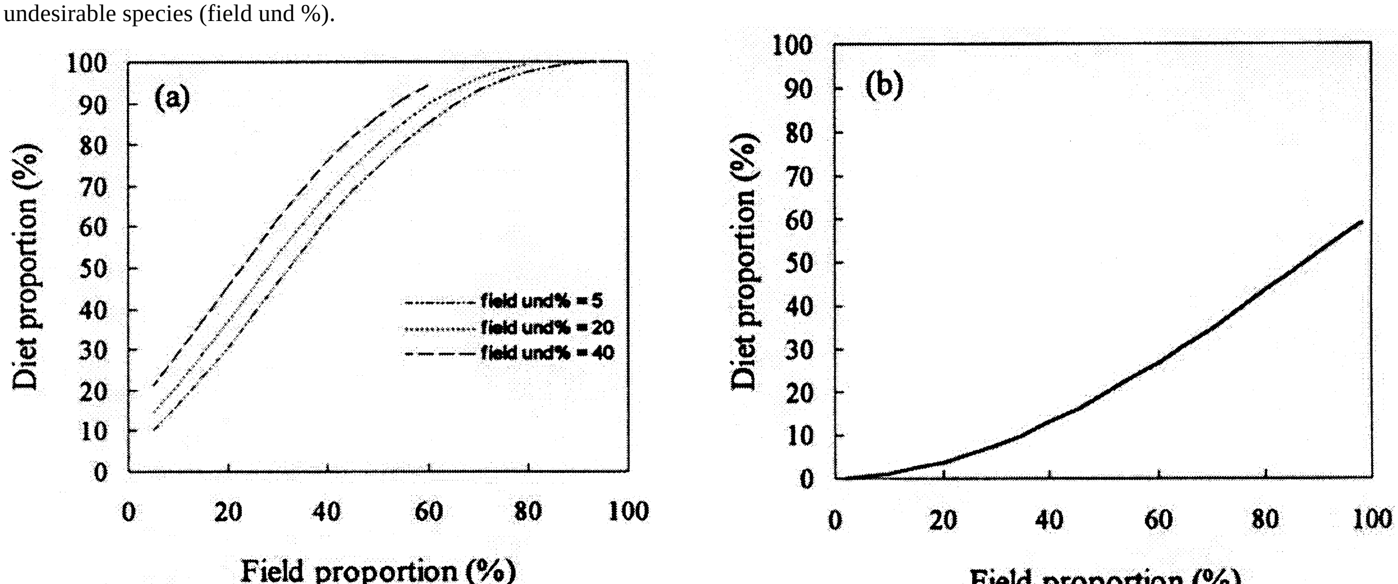

Figure 2

The effect of abundance of preferred species on safe stocking rate for cattle grazing post oak woodland in Texas.