BEHAVIOR – THE KEYSTONE IN OPTIMIZING FREE-RANGING UNGULATE PRODUCTION

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Summary

This chapter provides an overview on several topics paramount to understanding domestic free-ranging livestock foraging behavior. Animal behavior has always played a pivotal role in human management strategies involving domestic livestock, only within the last 30 years has there been a coordinated effort to try and use behavior principles in managing free-ranging livestock. Coupled with this focus has come advances in several key supporting sciences and technologies that impact today's domestic livestock management.

This combined package of information and awareness has resulted in a new focus on husbandry, once considered only art it is now enmeshed within the arena of science, ethics and animal welfare. What is known and what remains to be learned will provide domestic livestock production with opportunities that will benefit ecosystem stewardship as we move through the 21st century.

1. Introduction

The earliest recorded history of animal behavior is probably cave paintings from Paleolithic times depicting man hunting large mammals. The success of these hunts was intrinsically linked to "understanding" animal behavior. While the principles underlying all animal behavior are similar, this chapter focuses on domestic livestock.

Documentation of free-ranging domestic animal behaviors began early in the 20th century, but, it has only been since the 1950's that behavior has been considered an integral part of the disciplines of animal and range science. Even then, some did not believe grazing behavior studies contributed to the evaluation of management practices. However, the scientific consensus today is that the study and use of animal behavior principles is integral to the management of free-ranging herbivores.

Of the world's 13 x 10^9 ha of land surface about 30% can be associated with livestock use. The majority of land used for livestock can be considered to dry, too steep or too sloping for crop production and has been termed rangelands. These lands include deserts, forests and all natural grasslands. Rangelands represent 2.6 10^9 ha or about 20% of the earth's surface, however, it has been estimated that between 20% and 73% of this rangeland is degraded. Therefore, understanding and using animal behavior as a biological tool in restoration of these landscapes in both developed as well as the developing world will be essential for mankind in the 21st century and beyond. Today's lifestyle in the developed world has separated most people from the livestock that feed and cloth them. This alienation frequently has colored conceptions and understandings concerning livestock practices and processes. The goal of this chapter is to focus on how understanding animal behavior can be used to improve native landscapes as well as optimize food and fiber production from domestic free-ranging ungulates.

2. Defining Animal Behavior

Animal behavior has been defined as anything an organism does that involves action and response to stimulation —- the response of an individual, group or species to a whole range of factors constituting its environment which also includes muscle contractions. The word ethology, or the study of animal behavior, is derived from the Greek language and dates from approximately 1843. *Applied ethology* has been defined to describe behavior concerned with animal species that are of direct practical interest to people. Ethology may be one of the most complex fields of scientific study because differentiating and classifying what animals are doing and why, is not easily categorized, even when using tools such as video. This challenge was apparent in the early 1900's by a scientist who stated that the real difficulty in interpreting what an animal is doing lies not in the tendency to interpret animal intelligence in the terms of human experience, for we have no other way; but in the faulty and imperfect analysis of human experience.

The World Wide Web has made instantaneous access to published material a reality through a number of sites such as http://www.nal.usda.gov/awic/pubs/Beef/web.htm. However, at present no single site exists where all journals and textbooks pertaining to foraging animal behavior can be found. Details of what is presented in this chapter can be researched further using journals such as *Applied Animal Behaviour Science, Animal*

Behaviour, *Adaptive Behavior*, *Behavioral Ecology*, and *Sociobiology* and books listed in Table 1.

3. Concepts Fundamental to Foraging

3.1. Stocking rate

Stocking rate is an animal-to-area relationship. Stocking rate refers to number of animals placed on a particular area (paddock) over some time interval and is often expressed as number of animals or their equivalents per area of land. Common terms to express area are acres, sections, hectares or square kilometers. This calculation has been considered the most fundamental in the management of free-ranging animals and one of the four basic components necessary to properly manage free-ranging animals along with proper timing of use, distribution and grazing system. The actual numbers of animals to be place on the landscape depends on the kind and class of livestock and their daily forage requirements. Different kinds and classes of domestic livestock have been related to each other on the basis of animal unit (AU) equivalents (Table 2). An AU has been defined as one mature non-lactating bovine weighing 500 kg that is fed at a maintenance level or the equivalent, expressed as $(\text{weight})^{0.75}$. This information is essential when determining stocking. Furthermore, stocking rate should be determined before animals begin to forage. Too often, greed, ignorance or both have inflated this calculation and the result has frequently resulted in a long-term and devastating impact to the landscape. Stocking rates seldom remain constant over time due to variability in effective precipitation that directly affects plant growth and ultimately where animals forage on the landscape. As a general rule of thumb, the more arid the environment the more variable is the effective precipitation and hence the more conservative should be the stocking rate. Since standing crop and foraging are spatially dynamic alternative ways have been proposed on how stocking rate could be calculated including, determining the kilograms of body weight per ton of feed available. Another method would assume a set distance on either side of an animal's head is available at any point in time in which foraging could take place. If this distance (1 m might be a good estimate for a mature cow) is multiplied by the meters an animal travels, the area obtained would be more representative of where foraging may have occurred rather than using the area of the entire paddock.

Topic	Author or Editor	Title	Year, Editio	Publisher
Behavior	Hafez, E.S. E.	The behaviour of domestic animals	1962, 2nd	Williams and Wilkins
	Hafez, E. S. E.	The behaviour of domestic animals	1975, 3rd	Baillière, Tindall and Cassell
	Fraser, A. F.	Farm animal behaviour	1974	Baillière, Tindall
	Arnold, G. W., M. L. Dudzinski	Ethology of free-ranging domestic animals	1978	Elsevier
	Syme, G. I., L. A. Syme	Social structure in farm animals	1979	Elsevier
	Craig, J. V.	Domestic animal behavior: causes and implications for animal care and management	1981	Prentice-Hall, Inc
	Houpt, K. A., T.R. Wolsk	Domestic animal behavior for veterinarians and animal scientists	1982	Iowa State University Press
	Kilgour, R., C. Dalton	Livestock behaviour: A practical guide	1984	Westview Press
	Fraser, A. F.	Ethology of farm animals A comprehensive study	1985	Elsevier

		of the behavioural features of the common farm animals		
	Lynch, J. L., G. N. Hinch D. B. Adams	The behaviour of sheep biological principles and implications for production	1992	CAB Internationa
	Albright, J. L., and C. W. Arave	The behaviour of cattle	1997	CAB Internationa
	Keeling, L. J., H. W. Gonyou	Social behaviour in farm animals	2001	CAB Internationa
	Bolhuis, J., L. A. Giraldeau	The behavior of animals: Mechanisms, function, and evolution	2005	Blackwell Publishing
	Houpt, K. A.	Domestic animal behavior for veterinarians and animal scientists	2005	Blackwell Publishing
Rangeland Management	Clawson, M.	The western range livestock industry	1950, 1st	McGraw-Hill Book Co.
	Bell, H. M.	Rangeland management for livestock production	1973	University of Oklahoma Press
	Heady, H. F.	Rangeland management	1975	McGraw-Hill Book Co.
	Stoddart, L. A., A. D. Smith, T. W. Box	Range management	1975, 3rd	McGraw-Hill Book Co.
	Morley, F. H. W.	Grazing animals	1981	Elsevier
	Squires, V.	Livestock management in the arid zone	1981	Inkata Press
	Vallentine, J. F.	Grazing management	1990	Academic Press
	Heitschmidt, R. K., J. W. Stuth	Grazing management an ecological perspective	1991	Timber Press
	Heady, H. F., R. D. Child	Rangeland ecology and management	1994	Westview Press
	Holechek, J. L., R. D. Pieper, C. H. Herbel	Range management principles and practices	2004, 5th	Pearson Education Inc.

Table 1. Text books devoted to free-ranging animal behavior and the landscapes on which foraging takes place.

Kind and class of livestock	**Animal Unit Equivalent**
Cattle	
Weaned calves & yearlings	0.60
Mature cows with or without unweaned calf	1.00
Steers, 600 to 900 pounds	1.00
Bulls, 2 years old and older	1.30
Sheep and Goats	
Weaned lambs, kids or yearlings	0.12
Ewes or does with or without unweaned lambs or kids	0.20
Rams or bucks	0.26

Horses	
Yearlings	0.75
Two year old	1.00
≥3 years old	1.25

Table 2. Commonly accepted livestock animal unit (AU) equivalents. Adapted from Bell, 1972.

3.2. Animal density and stocking pressure

Stocking pressure or grazing pressure is an animal-to-forage relationship that has been defined as the ratio between number of animals expressed in AU equivalents and the mass of forage dry matter available per unit area at any point in time. Superficially the concept is easy to understand, but, in reality the full significance of this relationship to range animal ecology is complex and not fully explained by the current way in which it is calculated. The definition assumes the relationship is between foraging area and animal numbers, yet free-ranging animals seldom use the entire area available in an even and uniform fashion especially during foraging on rangeland. Furthermore, the impact of current foraging can be immense to future foraging as it impacts the physical and chemical properties of plant regrowth as well as soils. To date, these interactions are overlooked in this calculation. However, with global positioning system (GPS) technology and geographical information system (GIS) technology, alternative approaches exist that would provide a more accurate denominator.

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Biographical Sketches

Dean M. Anderson holds a BS in biology from the University of Southern Colorado; Pueblo, Colorado, a MS in agronomy from Colorado State University; Fort Collins, Colorado, and a Ph. D. in range science from Texas A&M University; College Station, Texas. Since 1977 he has been engaged in range animal ecology research with an emphasis on using free-ranging livestock behavior to accomplish management goals on the USDA-ARS Jornada Experimental Range located outside Las Cruces, New Mexico. He has authored or co-authored 96 peer reviewed journal publications, technical reports, bulletins and proceedings, several hundred abstracts and popular articles and has one U.S. Patent. He has traveled both nationally and internationally and has worked collaboratively with CSIRO in Rockhampton, Queensland Australia during 2005 and 2006 on virtual fencing.

Rick E. Estell has BS, MS, and PhD degrees in Animal Science from Purdue University, University of Tennessee, and New Mexico State University, respectively. He has conducted research regarding the role of plant chemistry in plant-animal interactions at the USDA-ARS Jornada Experimental Range, since 1989 and has authored over 70 scientific publications.