

Viewpoint: The Animal Unit as an Ecological Concept

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The animal unit (AU) has become a fundamental concept in grazing management, regularly used in various expressions of stocking levels and forage demand. It is surprising, therefore, that there still is a lack of consensus on what the AU actually describes. Recent definitions have defined the AU more precisely, but have failed to recognize the AU as a concept that integrates complex ecological effects from grazing. This paper argues for a return to a definition of the AU as an ecological concept.

In its earliest uses, an AU was equated to a cow or a cow with a calf (Jardine and Anderson 1919, Sampson 1923). Range professionals continued to use this definition for many years (Stoddart and Smith 1943, ASRM 1964, Heady 1975). From the 1950's, however, attempts have been made to define the unit more precisely. Initially a defined weight was assigned to the AU cow. For example, an AU was defined as a 1000 lb cow by Stoddart and Smith (1955) and as a 500 kg cow by Voisin (1959). To better correlate weight to forage needs, Edwards (1981) described an AU as a 1000 lb cow to the .75 power (the metabolizable energy requirement). Later, others defined an AU in terms of a cow of defined weight (1000 lb) but added a specific daily forage demand (e.g., 12 kg/day dry weight of forage (Holechek et al. 1989)). Realizing that forage demand varies among animals of the same weight but in different physiological conditions (e.g., lactation), several people dropped the animal weight definition and referred to an AU only in terms of a specific potential forage demand: (e.g., 25 lb/day (Vallentine 1990)).

This literature shows an evolution of the AU concept from a vague cow, to a cow of defined weight, to a cow of defined weight and forage demand, to a cow of defined potential forage demand. With each modification an attempt was made to make the concept more quantifiable, increasing its acceptability as a unit in planning and research. This process has, however, simplified the concept to the point where its usefulness is reduced in management applications. Furthermore, there remains considerable confusion on the definition of an AU as shown by the recent different definitions by Holechek et al. (1989) and Vallentine (1990).

Do the above definitions clarify what an AU actually describes? I think they do not. The range management profession has failed to adequately examine the AU and understand the concept as initially developed. The AU is a tool invented to help solve a problem. To understand what an AU expresses, it is helpful to understand the problem the unit was created to solve.

Derivation of the AU Concept

The earliest use of the concept was by U.S. Forest Service personnel charged with management of grazing allotments (Scarnecchia 1985). Their objective was to determine the number of cattle or sheep that a Forest Service allotment could support without realizing a decline due to grazing in the values derived from the range ecosystem (Jardine and Anderson 1919). To solve this problem they needed to know the effects of livestock on a specific area.

Livestock can have numerous effects on a range ecosystem, including forage harvesting, selective plant use, selective habitat use, trampling of herbage, site-specific bedding, trailing, soil compaction, surface pitting, mineral redistribution, and interactions with wildlife. This list is not exhaustive, but it illustrates the complexity of the potential effects of livestock presence.

Many years of data collection would be required to accurately determine the effects of a single animal on a range site. Such an undertaking was well beyond the scope of range managers who needed a quick method to estimate animal effects on a specific range allotment. There was no single unit in common usage that integrated these numerous effects into a single estimate of impact; so they created the AU. The unit was a very rough estimate of the effects over time (impact) of one cow with calf on an allotment (Hobbs and Carpenter 1986).

With time the concept has evolved to focus almost exclusively on the forage demand (estimated intake) effects of livestock. This is due in part to the fact that forage demand is often the most important effect determining proper stocking rates and in part to the fact that forage demand is one of the easiest impact variables to estimate. Jardine and Anderson (1919), however, considered variables such as selective forage use, selective habitat use, effects on tree seedlings, effects on hydrology and soils, and the presence of sensitive areas in their determination of the AU component in the carrying capacity, "grazing capacity," equation. Clearly in its earliest usages the AU had a broader meaning than forage demand. Jardine and Anderson (1919) measured forage in the now abandoned concept of "forage acres."

An AU as a Unit of Impact Rate

The impact of an animal on a specific range site is a function of the duration of its presence. An AU therefore, becomes a unit of impact rate.

$$\text{AU} \times \text{TIME} = \text{IMPACT}$$

$$\text{AU} = \text{IMPACT} / \text{TIME}$$

Only when a period of time is specified can the level of impact be estimated. Walking, lying, defecation, urination,

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habitat use, and forage and water consumption by a grazing animal are roughly repeated on a daily basis, making a day the shortest time period that integrates animal effects. For longer periods, days can be summed for the duration of animal presence. For periods of less than a day, as found with patch grazing in traditional pastoral systems, livestock activities during the period in question must be specified in detail to determine impact.

An important aspect of the initial AU concept was that it was referenced to effects of a standard animal, a mature cow or cow with calf. The rate of impact on a range site of a grazing animal depends on the animal's weight, forage demand, and behavior. For management applications the standard animal selected as a reference for the AU should be defined by species, breed, and class (Hinnant 1994) and be commonly found in local production systems. This fact has given rise to the numerous AU's found around the world, such as livestock units (450 kg) (Pratt and Gwynne 1977) and tropical livestock units (250 kg) (Bekure et al. 1991). The impact of animals exhibiting different behaviors can only roughly be correlated by comparisons of weight and forage demand alone.

Not all the impacts of livestock on an allotment are of equal importance for determining proper stocking rates. The initiators of the AU concept were aware of this and emphasized several effects of livestock when determining the AU component of stocking rate (Jardine and Anderson 1919). Managers must determine which effects are most important for specific ecosystems and production systems and emphasize those factors in their estimation of impact rate. Depending on ecosystem, production system, livestock type, and season, effects significant for management can result from defoliation, selective habitat use, trailing and soil compaction, mineral redistribution, and livestock-wildlife interactions. Note that some of these effects are controlled more by animal behavior than by animal weight or forage demand.

Problems with the Existing Definitions

The initial AU concept was defined in terms of a cow. Unfortunately, no one explicitly explained that it was the impact of a cow that the AU was expressing. Later work attempted to make the concept more exact by defining the cow in terms of animal weight and/or forage demand. These definitions simply told what an AU was equivalent to and failed to identify what an AU actually describes. An AU should not be considered a unit of weight or forage demand, but rather an expression of the total effects of a grazing animal (i.e., impact). Because the current definitions fail to define an AU in terms of impact rate, a new definition is called for.

Proposed New Definition

The following definition is proposed.

An animal unit is an estimate of the impact rate of a grazing animal on an ecosystem and is expressed in reference to those effects of a standard animal of defined species, breed, class, and weight that are most pertinent to the ecosystem being managed.

This definition acknowledges the complexity of the effects of livestock on an ecosystem and presents the AU as a rough estimate rather than an exact measurement. It accommodates all effects of an animal on a range ecosystem yet allows man-

agers to focus on those effects most pertinent to their situation. It notes the importance of a standard reference animal without quantitatively defining that animal, thereby allowing reference animals appropriate for local production systems to be used. It clearly defines an AU as a unit of impact rate. And finally, it highlights an AU as an ecological concept, a return to its initial use.

When applying this definition, managers must first determine which effects of livestock on a given range ecosystem are of greatest concern. This is often, but not always, defoliation. The spatial and temporal aspects of these effects need to also be considered. The effects might be spatially dependent; for example, concentrated grazing in riparian areas. The effects might be seasonally dependent; for example, livestock trampling and uprooting of vegetation early in the growing season. Once the impacts of greatest concern are identified, management strategies to mitigate these effects can be developed. This is what range managers have been doing for decades. By clearly defining an AU as an impact rate, rather than as a specific forage demand, the rationale by which stocking rates have been determined for different ecosystems becomes clearer.

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