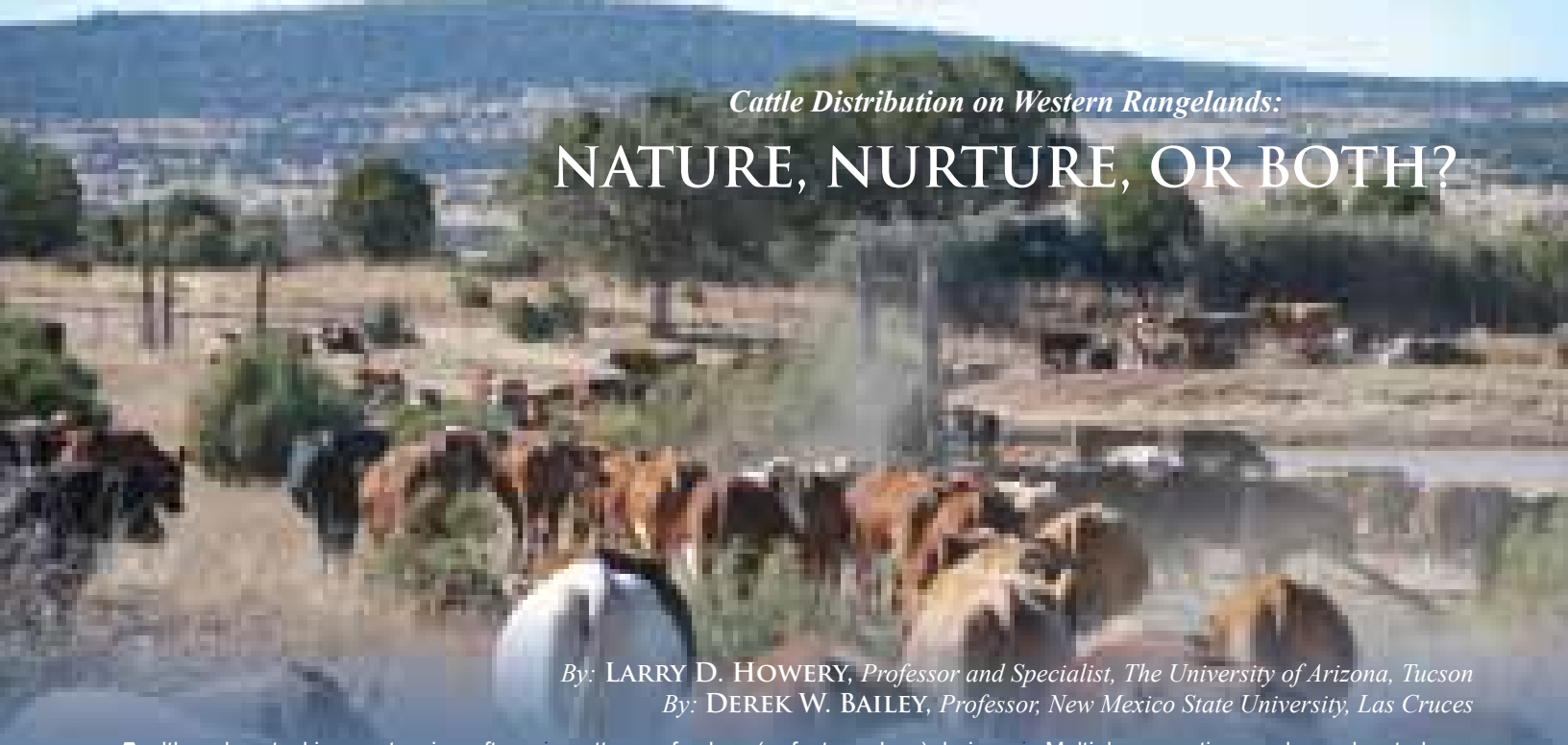

Cattle Distribution on Western Rangelands:

NATURE, NURTURE, OR BOTH?

By: LARRY D. HOWERY, *Professor and Specialist, The University of Arizona, Tucson*
By: DEREK W. BAILEY, *Professor, New Mexico State University, Las Cruces*

Although stocking rate is often described as the most important decision livestock managers make, most environmental concerns associated with cattle ranching in the western U.S. result from undesirable grazing distribution patterns. In the West, mountainous terrain and arid and semi-arid climatic conditions restrict where cattle are willing and able to go. Correspondingly, cattle typically congregate in gentle terrain and in areas near limited water sources. Ranchers recognize the importance of improving uniformity of grazing by using water, salt, supplement, fencing, and herding to encourage cattle to graze under utilized areas. Although these traditional range management practices can be effective, achieving proper animal distribution remains a major challenge for land managers especially in the arid West. Recently, researchers have been investigating new tools to manage cattle distribution by selecting animals that display desirable behavioral traits, which are apparently a product of nature and/or nurture.

A Case for Nurture

About 20 years ago, Howery and colleagues conducted a 4-year study to determine if mother cows influenced the distribution patterns of their offspring on a summer range grazing allotment near the Sawtooth Mountains of Idaho. The grazing allotment was located in rugged terrain and was bisected by 2 riparian areas called Maxfield and Thompson Creeks which were situated about a mile apart. The majority of the herd's grazing activities were centered around the Creeks with about half the cow-calf pairs preferring to stay near Maxfield Creek and its associated upland habitats while the other half preferred Thompson Creek and its associated uplands. The researchers followed the distribution patterns of calves (or foster calves) during their first year on the grazing allotment with their mothers, and continued to follow the same animals after they returned to allotment as replacement heifers or adult cows for 3 consecutive years. When the animals returned as one and a half-year-old replacement heifers, their terrain use was strongly influenced by their peers and their distribution patterns overlapped both Maxfield and Thompson Creeks. When the animals returned as 2.5-year-old cows, a drought caused Maxfield Creek to dry up which resulted in all of the animals to center their grazing activities around Thompson Creek where water was still available. Finally, when the animals returned as three and a half-year-old cows, the drought broke and water was once again available in both Creeks just as it was when the animals had grazed with their mothers as calves. Accordingly, the distribution patterns of the three and a half-year-old cows resembled those of their mothers' 3 years prior. The researchers concluded that peers, environmental conditions (i.e., drought), and mother (or foster mother) influenced the animals' grazing patterns throughout the four year study. In other words, cattle were able to respond and adapt to immediate and past experiences in their foraging environment.

A Case for Nature

More recently, Bailey and colleagues have identified genetic markers that are correlated with cattle use of rugged terrain and areas far from water. Approximately 770,000 genetic markers have been evaluated across the 30 pairs of bovine chromosomes and tested against GPS locations of cattle that were intensively tracked in New Mexico, Arizona, and Montana. The GPS locations were used to characterize grazing distribution with indices based on cattle use of slope, elevation, and distance from water. Multiple genetic markers located on chromosomes 4 and 29 accounted for 10-26% of the variation in how cattle used steep slopes and elevation gradients. These findings are exciting, because most individual genetic markers account for only 1-2% of the phenotypic variation in a trait. These results suggest that the heritability of grazing distribution may be similar to that of weaning weight, which has been the most economically relevant genetic trait in cow/calf operations for almost a century. Perhaps not surprising was the finding that some of the markers that influence animal distribution patterns also are correlated with feeding behavior, appetite, and locomotion.

Nature, Nurture, or Both?

So, is cattle distribution influenced by nature, nurture, or both (Fig. 1)? Howery and his associates demonstrated that natural mothers (as well as foster mothers) influenced the distribution patterns that their calves (and foster calves) exhibited later in life which provided evidence that learning where to graze from mother was an important nurturing factor that managers might be able to use to their advantage. They argued that selecting (culling) replacement heifers that were raised by mothers exhibiting desirable (undesirable) distribution patterns might help reduce problems associated with overuse of riparian areas. However, they cautioned that peer pressure and environmental vagaries also influenced the cattle grazing patterns that they observed in Idaho. Of course, a cow's genetic makeup is derived from both its mother and father and the Howery study was not designed to completely parse the influences of learning vs. genetics.

Bailey and colleagues argue that the relatively strong association between cattle terrain use and multiple genetic

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Figure 1. Hill Climber vs Bottom Dweller: Nature AND Nurture?

Photos were taken on the Todd Ranch near Willcox, Arizona. Courtesy of Steven Lunt.

shows that cattle grazing distribution is a heritable trait that is also influenced by nature (Fig. 2). These types of traits are typically referred to as heritability estimates (e.g., proportion of an observable behavioral, physiological, or morphological trait explained by genetics). Bailey and his associates plan to conduct future studies designed to verify and enhance prototype DNA tests that could be used to identify cows and bulls with desirable (or undesirable) grazing distribution genotypes. For example, these DNA-based results could potentially be used to identify bulls that will likely sire daughters that use more rugged topography and travel farther from water. Moreover, these tests could also be used to select (cull) cows with superior (inferior) genotypes, taking into account the contribution of both paternal and maternal genetics. Only a blood sample and DNA test would be needed at a cost of potentially less than $30 per animal. Furthermore, these tests and selections could be made without the need for expensive GPS tracking devices or intensive and repeated visual observations of individual animals as was done in the Howery study. Data obtained from an animal's DNA tests would provide information that could be used to estimate its genotype that is associated with terrain use and would in some ways be similar to Expected Progeny Differences (EPD's) that ranchers regularly use to select bulls and replacement heifers.

Summary

Disparate terrain use tendencies observed among individual animals are traits that are almost certainly affected by both nature and nurture (Figs. 1 and 2). Selecting or culling cows with favorable or unfavorable distribution patterns over several years would collectively improve distribution of a cattle herd through both nature and nurture mechanisms. However, this approach works best if movements of individual cows can be monitored to identify superior and inferior phentoypes. Unfortunately, intensively tracking individual cows in a cattle herd is likely to be cost prohibitive for most commercial ranches without development of new technologies that would reduce the effort needed to monitor grazing distribution patterns of individual animals. If Bailey and his associates' preliminary results can be verified, selection of bulls with favorable genotypes would provide ranchers and land managers with another tool to improve distribution patterns of entire herds without the need to track individual cows. These new tools would improve both economic and ecological sustainability of ranching as a land management enterprise. If you would like more information on any of the concepts presented in this article, feel free to contact either of the authors by email.

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Figure 2. Grazing distribution patterns of a Hill Climber heifer (7913, turquoise dots) and Bottom Dweller heifer (7710, pink dots).

Photograph shows steep rugged terrain used by heifer 7913 and relatively gentle bottom land with abundant water use by heifer 7710.

Heifers have different genotypes for a marker on chromosome 29 associated with indices of terrain use.

These heifers are examples of the potential differences in grazing distribution within a cattle herd when grazing rugged rangeland pastures.

Photos were taken on the Hartley Ranch near Roy, New Mexico, courtesy of Derek Bailey.