THE UNIVERSITY OF ARIZONA
COLLEGE OF AGRICULTURE & LIFE SCIENCES
Cooperative Extension

az1760 March 2018

Nature and Nurture's Influence on Cattle Distribution

Larry D. Howery and Derek W. Bailey

Introduction

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, especially on public lands. In the West, mountainous terrain and arid and semi-arid climatic conditions restrict where cattle are willing and able to go. For example, cattle typically congregate on gentle terrain and in areas near limited water sources. Cattle are typically reluctant to graze steep slopes, climb high ridges and travel long distances from water. These preferences can lead to excessive forage use on gentle terrain located near water, including riparian areas, while abundant forage on rugged terrain and areas far from water are left ungrazed. In summary, concerns with cattle grazing in the western U.S. are usually not a consequence of too many cows, but instead, are due to cattle selectively concentrating use in certain areas while avoiding other areas.

Ranchers recognize the importance of improving uniformity of grazing by using water, salt, supplement, fencing, and herding to encourage cattle to graze underutilized areas. Although these traditional range management practices are effective, they can be expensive, require regular maintenance, and may not be practical on some ranches due to a variety of reasons. Consequently, 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 collective product of both 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 1.5-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 mostly around Thompson Creek where water was still available. Finally, when the animals returned as 3.5-year-olds 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 3.5-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 4-year study. In other words, an animal's early experiences with mother certainly influenced its distribution patterns later in life, but cattle also adapted and responded to the immediate consequences their changing foraging environment

A Case for Nature

More recently, Bailey and colleagues have identified genetic markers (single-nucleotide polymorphisms, or SNPs) that are correlated with cattle use of rugged terrain and areas far from

water[1]. 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. Using statistical analyses, they were able to demonstrate that genetic markers on chromosomes 4, 8, 17, and 29 were associated with cattle grazing steep slopes, high elevations, and areas far from water. These findings are preliminary as they are based on 158 cows (500 animals is the desired minimum number of animals for most DNA studies). However, they are exciting because they demonstrate that grazing distribution is heritable. Perhaps not surprising was the finding that some of the same markers that influence animal distribution patterns also are correlated with feeding behavior, appetite, and locomotion in laboratory animals.

Nature, Nurture, or Both?

So, is cattle distribution influenced by nature, nurture, or both (Figure 1)? Howery and 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. In addition, a cow's genetic makeup is derived from both its sire and dam; the Howery study was not designed to quantitatively consider the influences of paternal and maternal genetics on cattle distribution.

Bailey and colleagues argue that the relatively strong association between cattle terrain use and multiple genetic markers near candidate genes shows that cattle distribution is a heritable trait that is also influenced by nature (Figure 2). These types of traits are commonly referred to as heritability estimates (e.g., proportion of an observable behavioral, physiological, or morphological trait explained by genetics). Additional studies are currently in progress to verify and enhance prototype DNA tests that could be used to identify cows and bulls with desirable (or undesirable) grazing distribution genotypes. Probably the most exciting part of this new research is that relatively inexpensive DNA tests (potentially less than $30/animal) based on blood samples could be used to determine if a bull would likely sire offspring that use more rugged topography and travel farther from water. Moreover, these same tests could be used to select or cull cows with superior or inferior "distribution" genotypes, taking into account the full contribution of both paternal and maternal DNA. Rather than fitting individual animals with expensive GPS collars, or making repeated visual observations of individual animals as has been done in previous studies, ranchers could simply collect a blood sample, send it for a DNA test that could be used to rank bulls (and cows) for their genetic potential to improve grazing distribution. This general process of using DNA to identify favorable "distribution" genotypes could be used in conjunction with the common practice of using Expected Progeny Differences (EPD's) that ranchers have used for years to select bulls and replacement heifers. These tests and selections could essentially eliminate the need for expensive GPS tracking devices or intensive and repeated visual observations of individual animals.

Figure 1. Hill Climbers vs Bottom Dwellers -- Nature, Nurture, or Both?

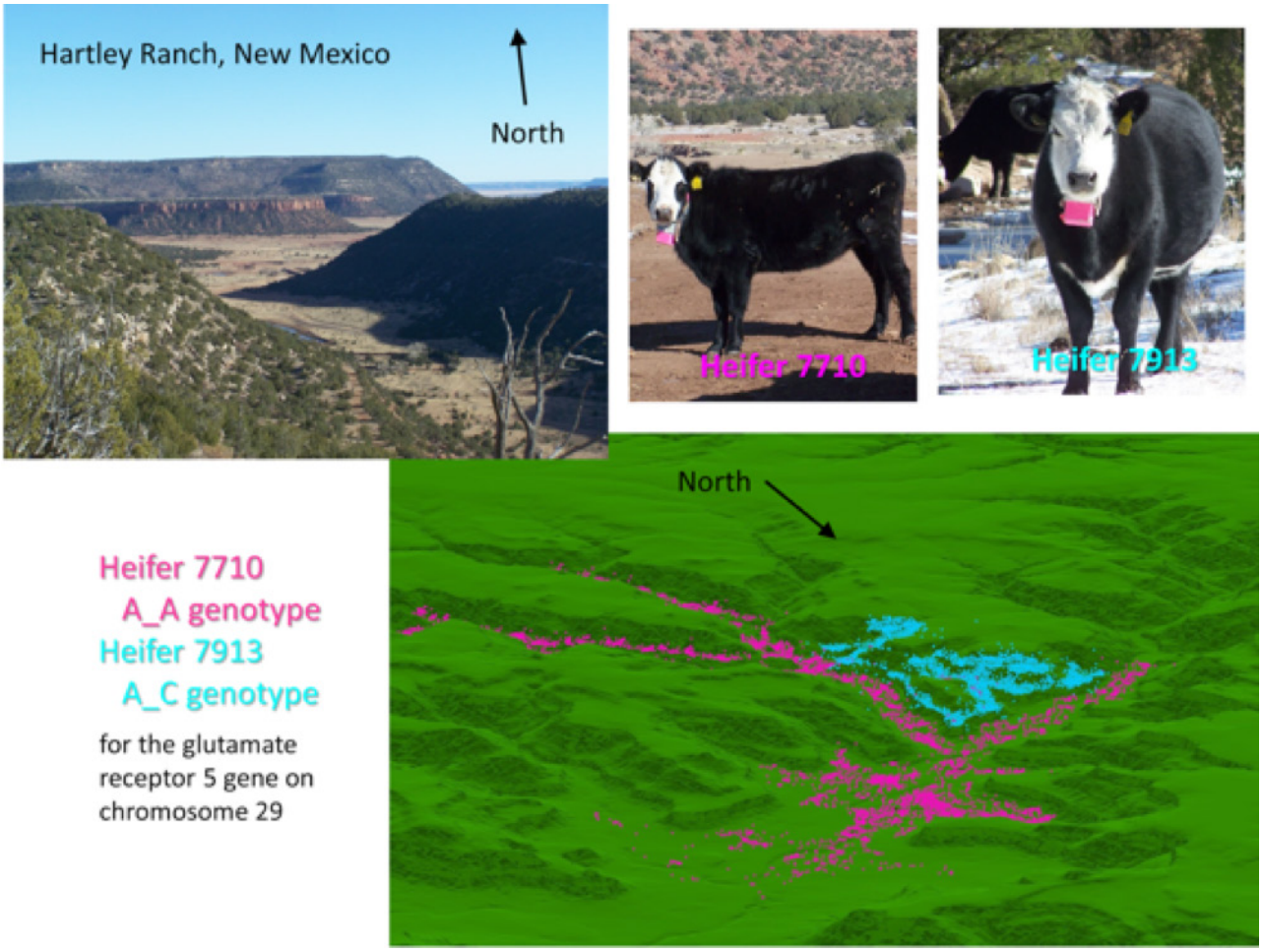

Figure 2. Grazing distribution patterns of two heifers at the Hartley Ranch located near Roy, NM. Heifers (7710 and 7913) had differing genotypes for a gene (glutamate receptor 5) on chromosome 29 that was associated with cattle distribution. Heifers were tracked from November to March at 15-minute intervals. The photograph in the top left corner provides perspective regarding the terrain in the pasture and the difference in the grazing patterns of the two heifers is shown on the 3D map on the bottom right.

Summary

Disparate terrain use tendencies observed among individual animals are traits that are affected by both nature and nurture (Figs. 1 and 2). Selecting or culling cows with favorable or unfavorable distribution patterns over several years could collectively, albeit slowly, improve distribution of a cattle herd through both nature and nurture mechanisms. However, this approach works only if movements of individual cows can be intensively monitored to identify superior and inferior phenotypes. Unfortunately, intensively tracking individual cows in a cattle herd over several weeks, months, and years is likely to be a time consuming and cost prohibitive endeavor for most commercial ranches.

We mentioned earlier that the results reported in this paper are preliminary but they lay the groundwork for more intensive research results that are currently being analyzed. If Bailey and his associates' preliminary results are verified, selection of bulls and cows with favorable "distribution" genotypes would provide ranchers and land managers with a powerful, time efficient, and relatively inexpensive tool to much more rapidly improve distribution patterns of entire herds without the need to intensively track and monitor grazing distribution patterns of individual cows. These new "broad brush" DNA tools have the potential to significantly improve both economic and ecological sustainability of working ranches on public lands by expanding the forage base for cattle while simultaneously attenuating overuse of riparian areas and other critical habitats. This article will be followed by additional papers on the concept of using DNA to predict how cattle use the terrain, a concept that ranchers and rangeland managers may find very useful.

References

1 Bailey, D. W., S. Lunt, A. Lipka, M. G. Thomas, J. F. Medrano, A. Cánovas, G. Rincon, M. B. Stephenson, and D. Jensen. 2015. Genetic influences on cattle grazing distribution: association of genetic markers with terrain use in cattle. Rangeland Ecology & Management 68:142-149.

THE UNIVERSITY OF ARIZONA
COLLEGE OF AGRICULTURE & LIFE SCIENCES
Cooperative Extension

The University of Arizona
College of Agriculture and Life Sciences
Tucson, Arizona 85721

Larry D. Howery
Professor and Specialist, The University of Arizona, Tucson

Derek W. Bailey
Professor, New Mexico State University, Las Cruces

Contact:
Larry D. Howery
lhowery@ag.arizona.edu

This information has been reviewed by University faculty.
extension.arizona.edu/pubs/az1760-2018.pdf

Other titles from Arizona Cooperative Extension can be found at:
extension.arizona.edu/pubs