Evaluation of herd instinct tags on cattle behavior and spatial distribution

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Abstract

On expansive rangelands, a major alteration to the historic grazing patterns is the lack of herd instinct that increased animal density and supported nomadic behavior. It is thought that re-instilling herd instinct into domestic livestock may mitigate the overuse of specific areas on rangelands and improve profit per acre, while supporting more diverse plant communities and wildlife habitat. A new technology is the Herd Instinct Tag (HIT) that utilizes audio and electrical stimuli to maintain animals at a defined herd density. HIT does not define borders, but rather tags communicate with each other to maintain herd density based on animal proximity. To test the HIT, 41 Hereford-cross animals were divided into two groups, HIT and control (CON), and evaluated for 5 weeks on the Mimms Division of the Dixon Water Foundation in Marfa, TX. Animals were maintained in separate pastures and recorded weekly to evaluate behavioral changes over time. There were no significant differences between treatments for any animal behaviors. Spatial distribution differed between treatments with the average distance between HIT individuals being 18.3 m, whereas the CON averaged 258.4 m between individuals. Ultimately, there were no indications that HIT affected animal stress levels following the use of HIT for 5 weeks. Animals with HIT successfully maintained a higher herd density but the long-term impacts on animal and rangeland health and production still need to be evaluated.

Introduction

Over the last 100 years increased attention has been placed on the state and revival of rangeland health, resulting in significant emphasis on extensive grazing systems and sustainable grazing practices (Kothmann 1974). During the mid-1900s, the management of livestock and rangelands became particularly centered on the creation of grazing systems that relied on the idea of rest-rotations, as opposed to traditional continuous grazing. These grazing rotation systems have various forms, including deferred rotation, short duration grazing, high intensity-low frequency, and adaptive multi-paddock grazing, which involve different approaches to the timing and duration of rest periods (Teague et al. 2013). Nevertheless, these systems commonly aim to mimic, to some degree, historic, migratory grazing patterns of native grazers (Teague et al. 2013; Bamforth 1987; Guy et al. 1981) that consisted of resource use followed by a nongrazing period, generally supporting landscape heterogeneity and co-existence of livestock and wildlife on rangelands (Behnke 2021; Chen and Shi 2018).

Within extensive rangeland scenarios there is a market for livestock management systems that producers can maintain use to desired stock density and support migratory grazing patterns where animals move as a unified herd. Because of this, a new technology coined the Herd Instinct Tag (HIT; RanchCheck, Inc., Marfa, Texas, USA) has been developed that focuses on re-instilling herd instinct into domestic livestock to support migratory grazing. HIT is a solar powered ear tag that utilizes audio and electrical cues to maintain animals at a user defined proximity that translates to herd density, but it does not define borders. Instead, the tags communicate with each other to determine and maintain herd density based on animal proximity relative to the center of the group. The goal of HIT is to promote innate herd instinct and promote animal grazing as a unified herd with minimal human intervention. As with any new technology, evaluating its influence on animal behavior and performance is crucial for successful implementation and widespread adoption. Therefore, our study objective was to assess the impact of HIT on animal behavior and evaluate its ability to maintain herd formation relative to "free ranging" animals.

Methods

The animals used in this experiment were registered and cared for according to guidelines approved by the Institutional Animal Care and Use Committee (AUP 2022-1163) at Texas Tech University.

On the Mimms Division of the Dixon Water Foundation in Marfa, TX (30.3929 ° N, 104.0622 ° W: elevation 1,432 m), a total of 41 yearling Hereford heifers and steers (318 ± 23 kg) were used to evaluate HIT. A total of 19 HIT were placed on animals. However, during the first week of observation, two animals in the HIT group lost their tags, resulting in 17 total tags for the full observation period. Animals were divided into two groups, HIT (17 operational HIT (65 g; n = 17) and control (CON, conventional ID tag (10 g; n = 24), and evaluated over a four-week period (February 24 – March 24, 2024). Animals were stratified by sex, nine heifers and ten steers initially received HIT, with random tag assignment within groups being performed by alternating between HIT and CON tags for every animal that entered the chute. Tag placement was performed by removing the current ID tags and fitting the assigned tag (i.e., HIT or CON) by securing it through the pre-existing hole in the ear. Following tag application, HIT devices were activated and each group was released into separate pastures (HIT 55 ha; CON 457 ha) out of the eyesight of each other. The HIT device was set to maintain a maximum distance of approximately 30 m between individuals. Although not optimal, the CON group was placed in a larger pasture due to a lack of similar-sized paddocks not out of eyesight of the HIT group, as well as grounding issues with electric fences. Data logged by the HIT included the continuous periodical relative proximity between the devices and all audio or electric cues.

Animals were maintained in their separate pastures and monitored weekly to evaluate behavioral changes over time using a modified ethogram of behaviors (Ranches et al. 2021). Individual animal behaviors were recorded using focal-animal sampling (Altmann 1984) for five minutes using a spotting scope with a mounted GoPro camera (GoPro Hero10 Inc. San Mateo, California, USA). Animal behavior monitoring was performed two days per week over a four-week period on the following dates: February 24 and 25, March 3, 4, 10, 11, 17, and 18 of 2023. All videos were taken at the same relative time each week, between the times of 8:00 AM to 6:00 PM Central Standard Time (CST), alternating between the two focal groups to ensure equal time sets for both morning and afternoon evaluations (e.g., HIT monitored during the morning on day 1 and afternoon for day 2). Behavioral analyses were performed by evaluating every 30 seconds of the recording. All recordings of individual animals were analyzed into observations by recording the primary behavior during the 30 second period. Observations were removed from the dataset if the animal being evaluated was out of view at any point. To evaluate spatial distribution, drone aerial images were taken between 11:00 AM and 2:00 PM CST for both groups. GPS positions of the cattle were obtained by georeferencing (Syetiawan et al. 2020) aerial pictures taken with a drone at a height of 200 meters in ArcGIS pro (ESRI, California, USA) and proximal distance between all animals within a group were determined by calculating the distances between their GPS positions.

All statistical procedures were performed using the MIXED procedure of SAS software version 9.4 (SAS Institute Inc., Cary, NC). Behavioral data were evaluated for the 2×2 factorial arrangement, considering treatment and week as fixed factors, with animal within group considered a random intercept. Distance data was evaluated to assess the effect of treatment and week using a completely randomized model. Normality and homogeneous variances were checked using Kolmogorov-Smirnov and Levene's tests, respectively. Mean comparisons were performed using Least Square Means for all significant effects ($P \leq 0.05$) and tendencies assumed at ($0.05 < P \leq 0.10$).

Results

There was no difference in post-tagging behavioral scores between the CON and HIT ($P > 0.05$). There was no interaction or main effect differences for any animal behaviors, with both CON and HIT spending similar proportions of time within each behavior category ($P > 0.05$). However, the spatial distribution assessment indicated a significant interaction between treatment and week ($P < 0.001$). Because the interaction appeared to be a result of social and environmental stressors, we compared treatments by week. The control treatment demonstrated significantly greater spatial distribution for all weeks ($P < 0.01$)

Discussion

Overall, time spent in all behavioral groups was similar between treatments. Feeding comprised >60% of behaviors, followed by locomotion and cohesive behaviors. Agonistic and agitation behaviors were <1% for both groups, indicating animal discomfort due to HIT was not present. According to Kilgour 2012, animals exhibiting <5% of these behaviors are considered to be in a state of comfort. Confirming the previous observation, both groups demonstrated high levels of cohesive behavior, with 10 and 15% for CON and HIT, respectively. We found that the CON group had numerically greater locomotion than the HIT group, which was surprising initially; however, this was likely due to individual animal movement within HIT group being constrained by the herd relative to the CON group and the greater pasture size of CON. Generally, our results follow the same trend found in virtual fence studies where no negative behaviors are noted following use of the technology (Lee and Campbell 2021; Verdon et al. 2021; Campbell et al. 2019).

The assessment of spatial distribution indicated a significant interaction between treatment and week, but this interaction can be largely attributed to CON in response to social and environmental stressors. There was no difference in distribution over time for HIT, with the average distance between HIT individuals being 18.3 m. In contrast, CON averaged 258.4 m between individuals with large weekly variations. The greatest distance between individuals was observed in week three for CON group (550.3 m), while the greatest distance for HIT herd was in week 4 (23.9 m). The HIT group in week two had the least distance between individuals (8.4 m), whereas the least distances for CON were in weeks one and four, 125 and 105 m, respectively. Overall, the HIT group maintained a single herd within a radius of no greater than 30 m, while the CON group divided into subgroups spaced up to 920 m apart.

Throughout the trial the HIT herd remained clustered, demonstrating the HIT's potential to maintain group density. In contrast, the CON group's proximity varied with their activity. For example, the CON herd would form a single group near water or supplement but disperse into subgroups during grazing events. The HIT group, however, maintained close proximity during all activities, including grazing, watering, and resting. When most of the herd wanted to rest, HIT individuals who wanted to graze stayed adjacent to the herd to maintain formation. Although anecdotal, evidence that suggests herd instinct was improved is that animals #2 and #6 lost their HITs midway through week one but did not stray from the herd even though they were no longer receiving cues. Although receiving only a brief period of exposure to the tags, these animals demonstrated strong herding behaviors and had to be moved to another paddock by ranch personnel.

There were no differences in animal behavior between animals that received CON vs HIT. The primary stressors observed in this study were associated with altered herd dynamics from splitting one herd into two and environmental stressors (i.e., freezing temperature, snow, and high winds). Animals with HIT maintained a close cluster formation which translates to a higher herd density. The HIT appears to adequately maintain herd dynamics without compromising animal welfare, but tag weight likely needs to be reduced to mitigate ear damage. Greater evaluation of tag weights is a prerequisite for future technology applications. Next steps for HIT require longer term evaluation of the technology and how it influences animal performance and ecosystem health.

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References
Altmann J. 1984. Observational Sampling Methods for Insect Behavioral Ecology. *Fla Entomol*. 67(1):50. doi:10.2307/3494104

Bamforth DB. 1987. Historical Documents and Bison Ecology on the Great Plains. *Plains Anthropol*. 32(115):1-16. doi:10.1080/2052546.1987.11909364

Behnke RH. 2021. Grazing Into the Anthropocene or Back to the Future? *Front. Sustain. Food Syst.* 5:638806. doi: 10.3389/fsufs.2021.638806

Campbell DLM, Lea JM, Keshavarzi H, Lee C. 2019. Virtual Fencing Is Comparable to Electric Tape Fencing for Cattle Behavior and Welfare. *Front Vet Sci*. 6. doi:10.3389/fvets.2019.00445

Chen M, Shi J. 2018. Effect of rotational grazing on plant and animal production. *Mathematical Biosciences and Engineering*. 15(2). doi:10.3934/mbe.2018017

Guy PR, Sinclair ARE, Norton-Griffiths M. Serengeti. 1981. Dynamics of an Ecosystem. *J Appl Ecol*. 18(1). doi:10.2307/2402507

Kilgour RJ. 2012. In pursuit of “normal”: A review of the behaviour of cattle at pasture. *Appl Anim Behav Sci*. 138(1-2). doi:10.1016/j.applanim.2011.12.002

Kothmann MM. 1974. Grazing Management Terminology. *Journal of Range Management*. 27(4):326. doi:10.2307/3896838

Lee C, Campbell DLM. 2021. A Multi-Disciplinary Approach to Assess the Welfare Impacts of a New Virtual Fencing Technology. *Front Vet Sci*. 8. doi:10.3389/fvets.2021.637709

Ranches J, O′Connor R, Johnson D, et al. 2021. *Effects of Virtual Fence Monitored by Global Positioning System on Beef Cattle Behavior*. Translational Animal Science. 5(S1):S144-S148. doi:10.1093/TAS/TXAB161

Syetiawan A, Gularso H, Kusnadi GI, Pramudita GN. 2020. Precise topographic mapping using direct georeferencing in UAV. *IOP Conf Ser Earth Environ Sci*. 500(1):012029. doi:10.1088/1755-1315/500/1/012029

Teague R, Provenza F, Kreuter U, Steffens T, Barnes M. 2013. Multi-paddock grazing on rangelands: Why the perceptual dichotomy between research results and rancher experience? *J Environ Manage*. 128:699-717.
Verdon M, Langworthy A, Rawnsley R. 2021. Virtual fencing technology to intensively graze lactating dairy cattle. II: Effects on cow welfare and behavior. *J Dairy Sci*. 104(6):7084-7094. doi:10.3168/jds.2020-19797