



# Livestock Bonding for Improving Paddock Management: A Maui Case Study

Matthew H. Stevenson<sup>1</sup>, Greg Friel<sup>2</sup>, and Dean M. Anderson<sup>3</sup>

<sup>1</sup>Department of Human Nutrition, Food and Animal Sciences; <sup>2</sup>Haleakala Ranch Company, Makawao, Maui;

<sup>3</sup>USDA Agricultural Research Service, Jornada Experimental Range (Retired)

## Summary

Applying an understanding of animal behavior principles can meet several ranch-management objectives. Research has demonstrated that differences in foraging behavior among cattle, sheep, and goats can help control undesirable vegetation at relatively low cost. However, increasing the number of animal species on a ranch will usually increase management labor or infrastructure costs. Haleakala Ranch on Maui conducted livestock bonding trials to evaluate this behavior-based method as a low-cost way to improve grazing management and forage use. Bonding produced interspecific livestock groups of cattle, sheep, and goats that consistently remained together when moved. This cohesive interspecific livestock grouping, termed a flerd (Figure 1), was formed by socializing the small ruminants with cattle through close association. USDA Agricultural Research Service studies conducted at the Jornada Experimental Range in south-central New Mexico on bonding for reducing coyote predation of free-ranging sheep and goats formed the basis of the Haleakala Ranch trials. Livestock bonding shows potential in Hawai'i for improved control of livestock distribution across a paddock, increasing paddock use efficiency, and providing another layer of protection from feral dog or pig predation on sheep and goats.

## Introduction

Ranching is a challenging profession worldwide, and Hawai'i is no exception. Hawai'i's ranchers and land managers must juggle extreme variation in rainfall,



**Figure 1. A “flerd” of cattle, white-faced sheep, and meat goats at Haleakala Ranch, Maui, HI, where interspecies social bonds have been formed to make management of multi-species stocking more efficient.**

drought, markets, policy measures, and land tenure. Many of our state's ranches cover vast acreage composed of both public and private lands. With the bulk of a producer's operating capital tied up in the current year's calf crop and over 2,500 miles of transportation cost added to most inputs, management options common on the mainland are often economically unfeasible in Hawai'i. Hawai'i ranchers consequently rely on their own creativity and import promising ideas to meet the challenges of producing high-quality livestock products. This paper describes one Maui ranch's experience with applying research-based principles that capitalize on

innate livestock behavior to improve paddock use, fight unwanted vegetation, and add a layer of protection for their animals.

## Multi-Species Stocking

### *The Benefits*

Just like the ranchers who tend them, free-ranging livestock must deal with incredible variability in their world. Paddocks with cultivated forage crops as well as rangelands present a nearly infinite combination of plant chemicals and nutrients that vary across a landscape, over the year, or even within the course of a day. Over millions of years of dealing with this variability, different foraging strategies evolved to help them survive on low-quality feed while competing with other herbivores. This in part explains how various grazing and browsing species can live side by side in a relatively uniform ecosystem like the African savanna (Odadi et al. 2011). Similarly, free-ranging cattle, sheep, and goats each rely on forages for their survival and production, but each does so in a slightly different way. This phenomenon has been particularly useful in weed or brush management. While it is certainly not a hard-and-fast rule, generally cattle prefer grasses, sheep choose broadleaf or herbaceous plants, and goats prefer browsing woody shrubs or trees (Figure 2). Managing all three species together can add up to more efficient forage use per unit of ground. For example, plants considered weeds for cattle production may be perfectly suitable as sheep forage. In this case, by running sheep with cattle, the plant that was once considered a weed is now an additional forage resource.



**Figure 2.** An example of leveraging differences in foraging behavior: a Big Island Ranch uses goats to control woody species like Christmas berry (*Schinus terebinthifolius*) (left) in a paddock used primarily for cattle. After browsing all the leaves in their reach, the goats proceed to debark the trees (right).

### *The Tradeoffs*

As the adage goes, “It takes money to make money,” and multi-species stocking does not come without a cost. Fences planned and installed for cattle may not work well for small ruminants (sheep or goats). Of the three species, goats can be particularly challenging to contain inside wire fencing due to their horns and their ability to climb. Furthermore, different species have reproductive cycles and health-management needs that may not synch well with other production priorities. A ranch manager, regardless of the size of the property, must balance personal and overall ranch goals and priorities with using multiple species to meet land-management objectives.

### **Haleakala Ranch Company, Makawao, Maui**

Growing beef cattle on over 30,000 acres up and down the slopes of east Maui, Haleakala Ranch has found multi-species stocking to be a natural fit for its incredibly diverse landscape. Ranch managers initially added goats and sheep to their operations in the fall of 2006 to deal with a who’s-who list of common range weeds in Hawai’i: apple of Sodom (*Solanum linnaeanum*), fireweed (*Senecio madagascariensis*), spiny amaranth (*Amaranthus spinosus*), joe ( *Stachytarpheta dichotoma*), Christmas berry, castor bean (*Ricinus communis*), and others (Figure 3). The addition was a success; owing to the grazing of the small ruminants, kikuyu grass and other desirable forages came back so strongly that cattle were brought into previously unusable paddocks ahead of schedule. Where the costs of herbicide and of spraying previously kept managers from opening up

weedy paddocks, now the sale of wethers and lambs will likely eventually pay for the cost of using small ruminants. The small-ruminant costs are mostly tied to two full-time personnel who oversee herding and care of the growing sheep and goat flocks. Also, the ranch purchased four Akbash guard dogs to protect the small ruminants against wild dogs and feral pigs. The guard dogs also act as an excellent deterrent to deer. Electric net fencing with solar chargers enables precise grazing of priority areas.

#### ***The Need: Better Forage Use and Paddock Rest***

Haleakala Ranch had developed a rhythm of following the cattle with goats and then sheep in their paddock rotations. However, keeping three separate herds meant three separate moves, which resulted in a seasonally longer total time a paddock was stocked before a rest period could begin than if the paddock were simultaneously stocked with a multispecies group of cattle, sheep, and goats.

#### ***The Solution: Livestock Bonding***

To improve paddock use efficiency, Haleakala Ranch managers found an innovative approach to managing mixed-species livestock, initially developed to reduce canine predation of small ruminants that were stocked with cattle on New Mexico desert rangeland. Normally, livestock species that have not been socialized, or bonded, forage separately across the landscape. Occasionally non-

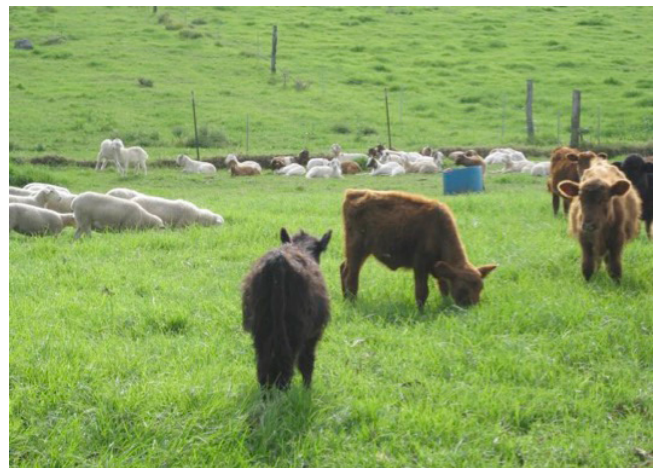
bonded livestock may come together at a mineral lick or when drinking if there is only one water source per paddock (Figure 4). Bonded livestock, however, act as a cohesive group that consistently can be found together as a “flerd” (flock + herd). Therefore, ranch hands can round up and transfer a flerd in a single move.

#### ***The Bonding Process and Applications***

Soon after sheep were introduced onto the USDA Agricultural Research Service’s Jornada Experimental Range (USDA-ARS, JER) in 1983, it became apparent that coyote predation would have to be addressed. Managers implemented a number of approaches including guard dogs, trapping, use of poisoned bait, and gunning from aircraft. To this mix of approaches researchers introduced bonding of small ruminants with cattle to create flerds. Overall, flerds reduced coyote predation among the small ruminants, especially when the sheep broke into more groups than the number of available guard dogs, because the sheep always remained in the presence of one or more cattle (Figure 5). This not only provided the small ruminants protection from coyotes but also reduced the time required to locate the small ruminants on brush-infested landscapes. The use of flerds also controlled the movement of small ruminants without the need for net wire fencing as long as the fencing was adequate to control the cattle, and it distributed foraging of the small ruminants over more of the landscape than was the case with flocks of non-bonded sheep.



**Figure 3.** A patch of apple of Sodom (*Solanum linnaeanum*) decimated by goats.



**Figure 4.** Even in this small paddock, goats (top) and sheep (left) that have not been bonded to cattle (foreground) tend to forage in separate groups.



**Figure 5. Border collie and Kelpie herding dogs were used to bunch and move the tightly formed flerd composed of sheep and goats bonded to cattle and move them through a gate in seconds (left). Non-bonded sheep avoid forming a group with cattle; therefore, each intraspecific group had to be moved separately through the gate into the new paddock (right), a process that required more time.**

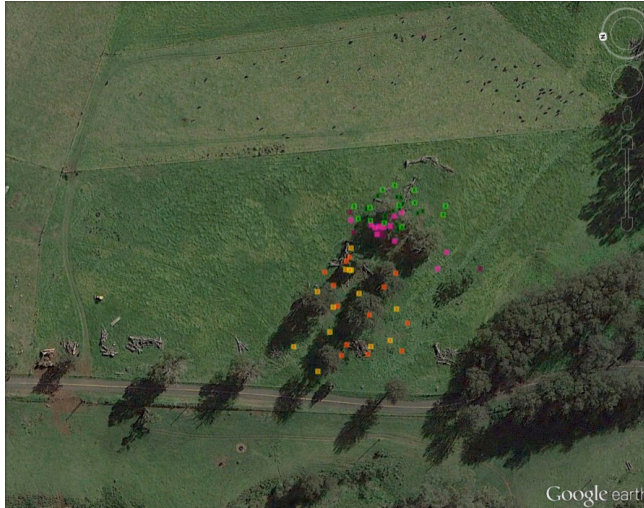
In general, bonding probably begins immediately when different species are placed together in close confinement, but it definitely has been shown to occur in white-faced sheep as early as 14 days after they have been confined with cattle of any age. Furthermore, the period of socialization among the species should be conducted with the least amount of interruptions possible. It is best to start the bonding process with the youngest small ruminants. Starting on the day of weaning is probably a good rule of thumb, though if this is practiced, the young animals should be provided with a creep area so they are able to escape from playful or abusive behavior that can be elicited by cattle. Exact details in how to accomplish bonding and what factors need to be addressed can be found in the literature at the end of this publication. Some of these articles can be found at Dean M. Anderson's page on the Jornada website (<https://jornada.nmsu.edu/people/Dean-Anderson>). Also available here are the videos "Response of Bonded and Unbonded Sheep to the Approach of a Trained Border Collie" and "Bonding and Mixed Grazing," which demonstrate some of the principles involved in creating and managing flocks. Evidence from unpublished data suggests socialization can begin almost immediately. However, the longer uninterrupted socialization takes place, up to 60 days after socialization among the species begins, the more confident one can be that a social bond has formed and forced confinement is no longer necessary.

The bonds appear to endure over time, even after three months of separation between bonded cattle and



**Figure 6. Two heifers, two goats, and two sheep from within a bonded herd were collared with GPS collars to study paddock use for a period of two weeks in December to January 2013–2014. A sub-group from a non-bonded herd were similarly collared for a two-week period in April to May 2014.**

small ruminants. However, young born to bonded ewes or does are not automatically bonded to cattle, and they too must go through a socialization process. The most likely protection provided the small ruminants by the cattle is through intimidation. Cattle, when threatened by a canine, will often attempt to face the canine and in doing so provide a safe center circle of space to which the bonded small ruminants will run. Rather than running off, bonded sheep and goats actively seek shelter



**Figure 7.** The spatial pattern of goats (dark and light green squares), and sheep (purple squares) that have been bonded to cattle (orange squares) plotted on a Google Earth image from the Haleakala Ranch, Maui, HI between 0800 and 0900 hours on January 2, 2014.

among the cattle, keeping the cattle between them and the threat. Bonding often appears to be unidirectional, because it is generally the small ruminants that appear more distressed than cattle if there is separation, but there may be some reciprocal socialization, based on the vocalizations of certain cows within cattle groups when bonded sheep and goats were removed.

#### ***Livestock Bonding and Paddock Use***

To examine paddock use in bonded versus non-bonded livestock groups, Lotek® Global Positioning System (GPS) collars were deployed. Two head of cattle were fitted with Model 3300LR units, while Model 3300S units were deployed on two sheep and two goats (Figure 6). Data were collected for two weeks in December 2013, on a 5-minute cycle from 0600 to 2100 and a 30-minute cycle from 2100 to 0600. Cattle, sheep, and goats not socialized to remain as a bonded group were similarly deployed with GPS collars in the same 50-acre paddock at Haleakala Ranch for a two-week period from April to May 2014.

The data downloaded from the GPS collars included latitude and longitude, providing animal locations on the landscape that were synched in time for both bonded and non-bonded groups. Square meters occupied by each of the two groups were recorded using the maximum



**Figure 8.** The spatial pattern of goats (dark and light green squares), and sheep (purple squares) that were not bonded to cattle (orange squares) plotted on a Google Earth image from the Haleakala Ranch, Maui, HI between 0800 and 0900 hours on April 24, 2014. Note the goats, bunched in the top left corner, remained separated from the other animals for the majority of the period as observed by the ranch manager.

distance between individual animals within the diameter of the circle enclosing each group. The mean linear distance between animals within each group was also calculated. Data collected during the first and last hour of each period of data collection were not included, as this represented handling of the animals. Also, data where latitude and longitude were not recorded were not included.

Bonded and non-bonded groups showed very distinct differences in how they used a paddock. The bonded group used much smaller square meter areas at any given observation time; i.e., bonded groups were found closer together at any given time compared to non-bonded groups. In contrast, the non-bonded animal groups consistently maintained large linear distances among animal species in the group. In the case of the non-bonded goats, they escaped from the study paddock and made no attempt to re-group with the other animals. GPS collar data are summarized in Table 1 and Table 2.

Figure 7 shows the location of a bonded group of animals on a Google Earth image of the Haleakala Ranch between 0800 and 0900 hours for January 2014. Note the spatial distribution pattern was typical for a bonded group in that individual animals within a species

**Table 1. Mean area (m<sup>2</sup>) ± standard errors occupied by goats and sheep bonded to cattle and non-bonded small ruminants (goats and sheep) with cattle and their respective range in areas. Means having similar superscripts are not statistically different ( $p < 0.01$ ) using a Student's *t* – test.**

Treatment	Mean area occupied by all species	Range in areas	Mean area occupied by small ruminants	Range in areas
Bonded	3,023 ± 91 <sup>a</sup>	29 – 31,030	869 ± 41 <sup>b</sup>	6 - 23,946
Non-bonded	101,176 ± 1,057 <sup>c</sup>	56 – 544,645	72,338 ± 981 <sup>d</sup>	15 – 544,645

**Table 2. Mean distance (m) ± standard errors between individuals within a species and treatment together with their respective range in distances. Means having similar superscripts are not statistically different ( $p < 0.01$ ) as determined with an Analysis of Variance (ANOVA) and Tukey-Kramer Test.**

Treatment	Mean distance between sheep	Range in distances	Mean distance between goats	Range in distances	Mean distance between cattle	Range in distances
Bonded	9.1 ± 0.2 <sup>a</sup>	0.2 – 104.5	9.6 ± 0.2 <sup>a</sup>	0.2 – 96.0	11.3 ± 0.2 <sup>b</sup>	0.1 – 78.3
Non-bonded	55.6 ± 1.3 <sup>c</sup>	0.2 – 814.1	17.0 ± 0.8 <sup>d</sup>	0.2 – 664.5	122.6 ± 1.7 <sup>e</sup>	0.3 – 526.5

remained together, but more importantly the three different animal species formed a close heterogeneous group (Figure 4). Even though all animals in the bonded group remained relatively close together once herding dogs were introduced into a paddock, the separate species sub-groups coalesced into one heterogeneous, closely associated bonded group that moved as a unit. Figure 8 is another selected Google Earth image between hour 0800 and 0900 on April 24, 2014, showing the spatial location of the non-bonded group. Goats in this group are noticeably separated from the sheep and cattle.

These data definitely indicate that small ruminants bonded to cattle show a different spatial pattern of orientation to these cattle on a landscape than do small ruminants that are not bonded. Further research should be conducted to focus on evaluating this difference with respect to paddock use to determine if cattle with groups of bonded sheep and goats graze more like small ruminants or vice versa? Economic and labor time analysis should also be studied to assist those considering adopting this management technique.

### *See the Flerd on the Web*

A brief video showing the Haleakala Ranch's flerd is available online at <https://www.youtube.com/watch?v=ywhB4ODFQsQ>. For more information on other behavior-based management principles and techniques to meet ranch goals, see the extensive videos and fact sheets at Utah State University's BEHAVE Network website at <http://www.behave.net>.

### **Acknowledgements**

Funding for this project was provided by the Western Sustainable Agriculture Research and Education Producer + Professional grant program (Project #SW12-114). The University of Hawai'i Institutional Animal Care and Use Committee reviewed and approved this study under protocol #12-1531.

## Dedication

This publication is dedicated to Matthew Henry Stevenson (January 26, 1979–May 22, 2016). He was an outstanding livestock Extension agent based in the Kaua'i Extension Office of the College of Tropical Agriculture and Human Resources, University of Hawai'i at Manoa. He cared for Hawai'i's resources that connected the land and the sea, where he enjoyed working with livestock and wildlife managed in diverse ecosystems where they thrived, and he loved working with the people whose lives he touched. "Too soon his light flickered, and vanished from our sight, still his memory burns bright." Aloha, Glen K. Fukumoto and Mark S. Thorne.

## Selected Bonding References

- Anderson, D.M., Hulet, C.V., Smith, J.N., Shupe, W.L., and Murray, L.W. 1987. Bonding of young sheep to heifers. *Appl. Anim. Behav. Sci.* 19:31–40.
- Anderson, D.M., Hulet, C.V., Smith, J.N., Shupe, W.L., and Murray, L.W. 1987. Heifer disposition and bonding of lambs to heifers. *Appl. Anim. Behav. Sci.* 19:27–30.
- Hulet, C.V., Anderson, D.M., Smith, J.N., and Shupe, W.L. 1987. Bonding of sheep to cattle as an effective technique for predation control. *Appl. Anim. Behav. Sci.* 19:19–25.
- Anderson, D.M., Hulet, C.V., Shupe, W.L., Smith, J.N., and Murray, L.W. 1988. Response of bonded and non-bonded sheep to the approach of a trained border collie. *Appl. Anim. Behav. Sci.* 21:251–257.
- Hulet, C.V., Anderson, D.M., Smith, J.N., Shupe, W.L., Taylor, C.A., Jr., and Murray, L.W. 1989. Bonding of goats to sheep and cattle for protection from predators. *Appl. Anim. Behav. Sci.* 22:261–267.
- Anderson, D.M., Hulet, C.V., Hamadeh, S.K., Smith, J.N., and Murray, L.W. 1990. Diet selection of bonded and non-bonded free-ranging sheep and cattle. *Appl. Anim. Behav. Sci.* 26:231–242.
- Hulet, C.V., Anderson, D.M., Smith, J.N., Shupe, W.L., Murray, L.W. 1991. Bonding of Spanish kid goats to cattle and sheep. *Appl. Anim. Behav. Sci.* 30:97–103.
- Anderson, D.M., Hulet, C.V., Smith, J.N., Shupe, W.L., and Murray, L.W. 1992. An attempt to bond weaned 3-month-old beef heifers to yearling ewes. *Appl. Anim. Behav. Sci.* 34:181–188.
- Hulet, C.V., Anderson, D.M., Nakamatsu, V.B., Murray, L.W. and Pieper, R.D. 1992. Diet selection of cattle and bonded small ruminants grazing arid rangeland. *Sheep Res. J.* 8:11–18.
- Hulet, C.V., Anderson, D.M., Shupe, W.L., and Murray, L.W. 1992. Field versus pen bonding lambs to cattle. *Sheep Res. J.* 8:69–72.
- Anderson, D.M., Havstad, K.M., Shupe, W.L., Libeau, R., Smith, J.N., and Murray, L.W. 1994. Benefits and costs in controlling sheep bonded to cattle without wire fencing. *Small Rumin. Res.* 14:1–8.
- Anderson, D.M., Estell, R.E., Havstad, K.M., Shupe, W.L., Libeau, R., and Murray, L.W. 1996. Differences in ewe and wether behavior when bonded to cattle. *Appl. Anim. Behav. Sci.* 47:201–209.
- Anderson, D.M. 1998. Pro-active livestock management – Capitalizing on animal behavior. *J. Arid Land Studies.* 7S:113–116.
- Fredrickson, E.L., Anderson, D.M., Estell, R.E., Havstad, K.M., Shupe, and Remmenga, M. 2001. Pen confinement of yearling ewes with cows or heifers for 14 days to produce bonded sheep. *Small Rumin. Res.* 2051:1–7.
- Anderson, D.M. 2004. 2004. Flocks and herds or flerds --- the choice is yours. *Grass Roots - Newsletter of the Grassland Society of Southern Africa.* 4(2):16–22. The article is available at <http://www.gssa.co.za/bulletins/200406.pdf>
- Anderson, D.M., Murray, L.W., Sun, P., Fredrickson, E.L., Estell, R.E., Nakamatsu, V.B., 2011. Characterizing foraging patterns among cattle and bonded and non-bonded small ruminants using spatial point process techniques. In: Song, W. Proc. 22<sup>nd</sup> Ann. Kansas State Univ. Conf. Appl. Stat. Agri. Manhattan, KS: Department of Statistics, Kansas State University, 12–35.
- Anderson, D.M., Fredrickson, E.L., and Estell, R.E. 2012. Managing livestock using animal behavior: mixed-species stocking and flerds. *Animal.* 6(8):1339–49.

Please contact Dean M. Anderson at [timaebellanderson@outlook.com](mailto:timaebellanderson@outlook.com) if you have trouble downloading or accessing any of the above articles or the two videos.

## Literature Cited

- Odadi, W.O., Karachi, M.K., Abdulrazak, S.A., and Young, T.P. 2011. African wild ungulates compete with or facilitate cattle depending on season. *Science* 333 (6050):1753–5.

Thorne, M., Fukumoto, G., and Stevenson, M. 2007. Foraging behavior and grazing management planning. College of Tropical Agriculture and Human Resources, University of Hawai'i at Manoa. Pasture and Range Management (PRM-2), 11 pages. <http://www.ctahr.hawaii.edu/oc/freepubs/pdf/PRM-2.pdf>