2021 Project Progress Report:
Maternal Influences Upon Calf Adaptability to Rangeland

PERSONNEL:
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PRELIMINARY RESULTS for 2021:

BACKGROUND

Our recent research (Sprinkle et al., 2021a), suggests that "efficient" 2-yr-old lactating cows use rugged rangelands more sustainably than "inefficient" 2-yr-old lactating cows. Cows that were previously ranked as more efficient in a feedlot setting (using data from GrowSafe™ feeding units) climbed higher and spent more time out of the riparian areas at Rinker Rock Creek Ranch (**RRCR**) during the hot days of August.

Further consideration of the differences we saw in the spatial distribution of cattle grazing these rugged rangelands during the heat of summer implied that there was a physiological link to the grazing behavior demonstrated by these divergent cattle. Specifically, cattle with greater appetite spend more time resting during the heat of the day at lower elevations due to a larger gastrointestinal tract size. In other words, a bigger "engine" generates greater metabolic heat load.

However, it is simplistic to suggest that differences in grazing behavior among these divergent cattle in the hot days of late summer are solely influenced by anatomical differences in the size of the digestive organs, though this influence is strong. Likely, there are also learned and inherent grazing behaviors that are unique to either efficient or inefficient cattle. Limited research suggests that the influence of feed efficiency upon grazing behavior leads to differences in harvesting efficiency (Sprinkle et al., 2019).

Are differences in grazing behavior that have been observed for efficient vs inefficient cattle grazing rugged rangelands due to 'nature' or 'nurture'? How important is the role of social learning? Launchbaugh and Howery (2005) reiterated the premise that the "*most important models for social learning for a young animal were its mother and young companions"*. Furthermore, they stated that "*Mother markedly influences the establishment and persistence of her offspring's diet and habitat-selection patterns."*

If the differences in grazing rugged rangelands can be attributed mainly to genetic influences, then selection of replacement heifers could be aided by using genetic markers as those become available. Recent research (Bailey et al., 2015) suggests that genetic markers may exist to classify "hill-climber" cows that better fit rugged rangeland environment.

Numerous studies suggest that the influence of 'mother' declines as offspring mature (Launchbaugh and Howery, 2005). Anecdotal and scientific studies also affirm that younger animals grazing rangelands spend less time following mother as she is engaged in morning and evening grazing bouts and more time in the presence of a "guard" cow. As a calf starts eating more forage and relying less on mother's milk, the opportunity for social learning may increase. Calves aged 2 to 3 months can be expected to consume approximately 20 to 40% of the dietary calories from forage but up to 40 to 70% at 3 to 5 months (depending upon year and cow milk production; Ansotegui et al., 1991).

This research fits within the *sustainable range livestock production* mission of the David Little Livestock Range Management Endowment. Not only is it important to have resilient rangelands, it is also important to have cows that fit those rangelands, especially as climate change contributes to hotter, longer summers. As we search for the optimal cow to fit Idaho rangelands, it is important to determine how cattle distribute over rugged

rangelands and how that is influenced by both nature and nurture. Can we just select replacement heifers based upon phenotypic and genotypic data, or should we also consider the influence of social learning?

HYPOTHESES/OBJECTIVES

We hypothesize that calves from efficiently ranked cows will follow mother as the calf ages and temperatures increase, and that grazing behavior will differ, with calves from efficient cows accessing more difficult slopes and spending less time resting during the heat of the day than calves from inefficient cows. Additionally, we hypothesize that cows differing in feed efficiency will exhibit differences in grazing behavior and grazing distribution, with efficient cows traveling further and grazing more of the available pasture. We also hypothesize that efficient and inefficient cattle will differ in the amount of time spent grazing, resting, and walking.

Grazing Behavior & Livestock Grazing Distribution Objectives. 1) Determine if 4 to 7-yr-old cows differing in efficiency will exhibit differences in grazing time, resting time, walking time, commencement of grazing, grazing resource selection, distance traveled, and elevational gain, while grazing a common pasture. 2) We will also determine how this behavior changes from mid-lactation to late lactation, accompanying decreased milk production and increased ambient temperatures. 3) Evaluate calves from these cows for grazing distribution and resource use in both mid- and late lactation using GPS technology and explore the use of accelerometers to help predict calf grazing behavior (walking, resting, grazing, nursing).

PROCEDURES

Experimental Pastures and Animals. This research is occuring at RRCR, 11 miles southwest of Hailey, Idaho. Approximately 165 cattle will graze upland range pastures from approximately mid-May until mid-October with calves being weaned in mid-September. From within this group of cows, a subset of 36 four to 7-yr-old cows and their calves will be selected (18 efficient; 18 inefficient) to carry grazing collars (Sprinkle, 2021b; Figure 1) containing both accelerometers and GPS loggers. Accelerometers are used on rockets to measure velocity in three different directions and we have successfully paired head movements of cattle with accelerometer readings to determine grazing behavior (resting, walking, grazing throughout the day). Grazing locations and other GPS data will be determined on 5-minute intervals and daily accelerometer activity will be evaluated at 5 second intervals. Collars will be installed for the first experimental period at turnout, then each cow and calf will have their behavior (grazing, resting, walking + suckling for calves) observed in a smaller pasture over 4 days in order to obtain a "data signature" for the recorded accelerometer data. One person can follow 12 cows or calves/day.

Data will be collected by horseback observers during peak grazing periods in early morning and later afternoon as well as during resting time at mid-day. Cows will then be trailed to upland pastures and additional walking behavior will be recorded. Additionally, calf suckling behavior will be determined when measuring milk production in cows by weigh-suckle-weigh procedures when collars are mounted. Collars will be removed from these cows and calves after 3 to 4 weeks and then reinstalled around the end of July, following the same procedures. Although accelerometers have been used to monitor suckling behavior in young calves, little or no work has been done with suckling calves to determine grazing behavior. We anticipate that grazing behavior data for calves less than 4 months of age may be difficult to determine and we may only obtain reliable GPS data for the first sample period. However, we anticipate that we will be able to obtain reliable accelerometer data on calves as they graze more later in lactation. Weather data from the nearest remote weather station will be compared against daily cattle behavior to quantify the effects of climate upon animal behavior. It should be mentioned that an accompanying study will split the 36 cows in each group and their calves into two groups and cows will either receive or not receive an injectable trace mineral (ITM).

Production Data. All cattle (including collared cattle) will be weighed and scored for body condition (cows only) each time collars are mounted or removed. Adjusted calf weaning weights and cow pregnancy status will be determined at weaning.

Forage Utilization and Production. Forage production will be collected prior to the first cattle entry at 1 or more locations within the experimental pastures with 20 randomized 0.16 m^2 quadrat frames at each location. These samples will be further evaluated for forage quality (digestibility and crude protein). Forage utilization will be evaluated by either the landscape appearance or height:weight utilization gauge method.

Statistics: Cow and calf grazing behavior data will be analyzed within each sample period by mixed model procedures for repeated measures with RFI group, ITM treatment, date, ITM treatment x date, and RFI group x date as fixed effects and cow (or calf) within RFI group x ITM treatment as a random effect. Production data will be analyzed by a mixed model procedures for repeated measures with RFI group, ITM treatment, cow age, sampling date, year, and RFI group x ITM treatment as fixed main effects and cow or calf within RFI group x ITM treatment as a random effect.

Figure 1. A research cow is outfitted with a collar containing both a GPS and accelerometer logger. The GPS module is being pointed to in the picture on the left.

ACCOMPLISHMENTS/PRELIMINARY RESULTS for 2021:

In our original funding request, we requested $11,250 to assist in constructing 50 of 75 homemade grazing collars. We were fortunate to receive $2,000 from the David Little Livestock Range Management Endowment with an equal match from the Rangeland Center. When I investigated assembling the components needed for collar construction, I found out that the GPS loggers we were planning on using would possibly be backordered for a year or more due to the pandemic. However, I found that the company we had purchased accelerometers from was willing to work with us in developing a combination logger that contained both an accelerometer and a GPS logger. Therefore, I worked closely with Gulf Coast Data Concepts from Mississippi from November 2020 to April 2021 to develop the new unit. We conducted two on farm tests at NMCREEC in February and March to test prototype equipment before approval of the final design (Figure 1; logger that is housed within a PVC housing). It is an advantage to have the GPS and accelerometer data stitched together in one data stream but the costs of this all-inclusive logger was greater ($315/unit). I scrounged funding from two additional funding streams to pay the total costs ($23,625) of the 75 collars used for this project.

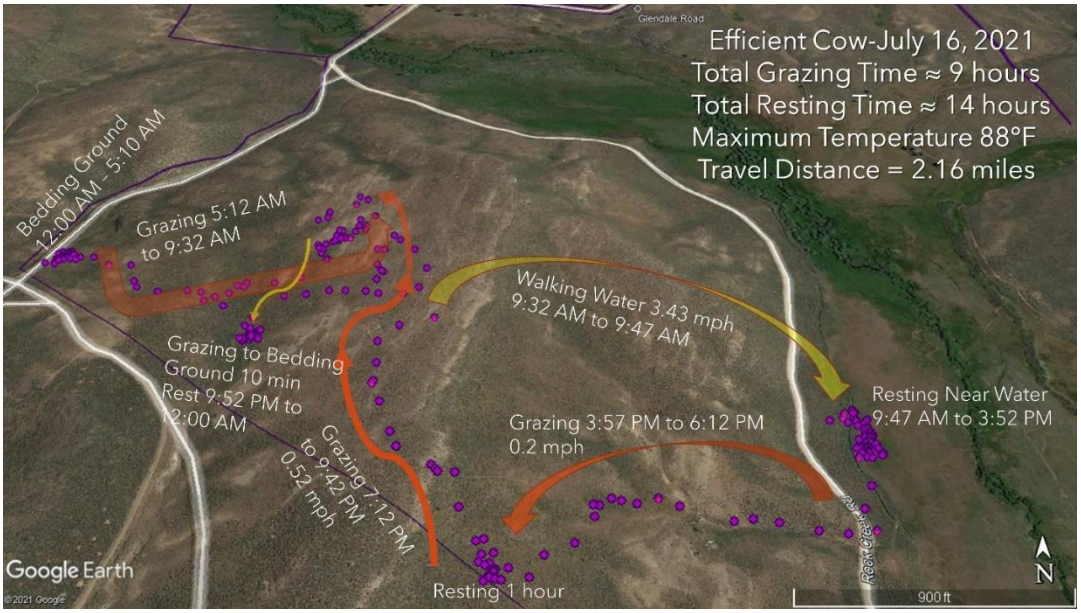
The grazing behavior collars were installed on 35 cows + calves (1 cow/calf eliminated due to calf lameness) at RRCR during mid (May 18 to June 16, 2021) and late lactation (July 12 to August 25, 2021). After collar deployment this summer, we found that the firmware (software) for the loggers needed to be updated to prevent "brown-out" of the printed electronic circuit board. During the first sample period, we recovered an average of 19 days data for cows and 13 days for calves. During the second sample period in which ambient temperatures achieved a 90°F maximal temperature, the days of recovered data averaged 6 days for cows and 4 days for calves. Gulf Coast Data Concepts ran diagnostics on five loggers and determined the following (in engineer speak): "*Initially, we thought the errors were due to an unstable clock signal to the CPU (phase lock loop). Instead, further testing indicated a problem within the power supply design. The code change specifically addresses the power supply chip. This chip actively changes the power output depending on the load requirements. Write operations to the flash memory require large power surges but the chip was not reacting properly (not delivering sufficient power quickly). The code change commands the chip to enter a high power mode when needed by the flash memory chip. This eliminates the failed memory writes (0 kb data files) and early shutdown (brown-out of CPU).*" Gulf Coast sent me a laptop using their operating system (Linux) in September 2021 and I was able to update firmware for all the data loggers. Additionally, at their request, I removed the printed circuit boards and sprayed them with an acrylic conformal coating to help weatherize the loggers. We are confident that the firmware update will eliminate data recording problems for the data loggers and that they will now recover data for 30 days with little problem. I will be testing 35 loggers from late October until late November 2021 on another project at Malad, Idaho. We are hopeful and confident that electronic data collection in 2022 will be much more robust than what we observed in late summer of 2021.

On a positive note, data recovered from these units appear to be highly accurate with much less erroneous GPS waypoints (flying off from the actual location due to poor satellite locks) than the GPS units I had used previously. Figure 2 shows the data recovery from one efficient cow on July 16, 2021. She arose at 5 AM to

commence grazing, grazed until 9:30 AM, walked quickly to water, stayed there until near 4 PM, grazed again until around 10 PM with one hour of resting, then went to bed again from around 10 PM onward.
Figure 2. Grazing behavior during the heat of summer.

PUBLICATIONS/OUTPUTS:

We look forward to continuing this data collection for another year. This project has already received considerable interest and will be the subject of a future *Life on the Range* video production. We were interviewed and filmed by Steve Stuebner in May of 2021 at RRCR. Some of this initial story is featured on the Life on the Range Facebook page



https://www.facebook.com/lifeontherange/posts/visited-the-rinker-rock-creek-ranch-today-for-a-research-story-about-genetic-and/3991896690879691/ .

The methodology for using accelerometers for predicting grazing behavior was published by some of the members of our research team in the *Rangeland Ecology and Management* journal in 2021 (Sprinkle et al., 2021b) and is listed below. With this published article, we have a sound underpinning for publishing future grazing behavior research at RRCR and elsewhere.

Dr. Brenda Murdoch's research lab at the University of Idaho has been cooperating with us in the analysis of DNA to look for genetic markers for cattle related to terrain use and grazing behavior. Her graduate student, Morgan Stegemiller, will be presenting gene marker research derived from our prior grazing behavior research at RRCR at the Western Section, American Society of Animal Science Meeting in Fort Collins on October 19, 2021. Morgan found 5 gene marker regions in our experimental cattle that related to terrain use and grazing behavior, explaining from 43 to 52% of the animal variance for grazing time, walking time, maximum slope, and time spent on slopes > 15 degrees (Stegemiller et al., 2021). We are excited about these results and look forward to additional information to be contributed by our current research.

We hope to receive travel funding from the David Little Livestock Range Management Endowment for data collection at RRCR in 2022 to assist in the continuation of this project and will be requesting $6,000 in the 2021 request for proposals. Look forward to more actual grazing behavior results form our research next November!

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Figure 3. Hadley Dotts, UI RRCR Intern, assists with grazing behavior data collection in July 2021.