GPS Collars Allow Cattle to Tell Us How They Use Their Pasture

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Rangeland scientists and managers often want to know how livestock behave in their pastures, but commercial systems for tracking animal activity are costly. I constructed a do-it-yourself (DIY) system that can be strapped to livestock and takes GPS readings at fixed intervals for a little more than a month for only about $125. We ran about 40 of these units at the CGREC throughout the 2018 grazing season, collecting fine-scale information about where and when cattle choose to graze. We found they responded very well to patch burning and often concentrate their grazing in recently burned patches.

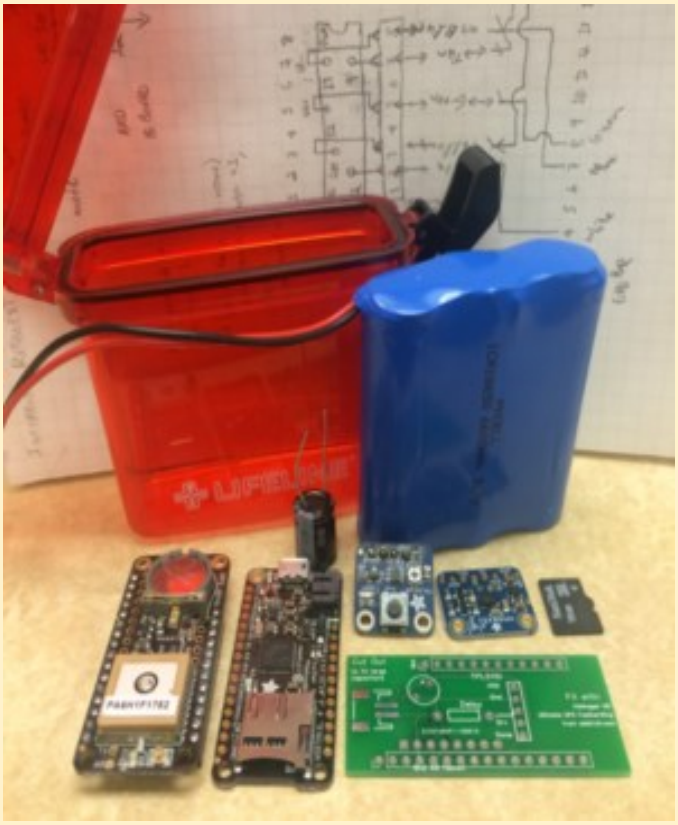
Introduction

At first glance, a cow's life doesn't seem terribly complex: Her main objective is to find enough grass to keep her belly full, punctuated with taking a few drinks of water and standing still long enough for her calf to nurse. But in rangeland pastures, she's faced with a surprising amount of choice: what grass to eat, where to get those drinks of water, and where to loaf around to feed her calf and chew, chew, chew that cud.

Taken together, all the grazing, stomping and loafing of a whole herd of cows can have substantial effects on the range in terms of soil compaction and nutrient deposition, forage removal and productivity, and the height and density of vegetation that rangeland wildlife count as their habitat. Range managers have put a lot of research and effort into coming up with ways to help steer cows around the pasture, so to speak: water and mineral distribution, fencing systems even patch burns such as in the research at the CGREC.

But do these schemes work? Does cattle behavior actually respond to management? We can monitor all the potential impacts - soil health, forage production, plant species composition - but to really attribute those patterns to livestock behavior requires insight into how they use their pasture.

As in so many cases, the techie types have come up with several solutions to spy on our herds. Livestock can be fitted with all sorts of monitoring and tracking devices that record when they get close to specific sensors, such as at water or a creep feeder, or even where they are at any point in time, using Global Positioning Systems technology (GPS). But strapping sensitive electronics onto an animal for a season on the range requires ruggedness and extended battery life all in a small package. Thus, commercial GPS livestock tracking systems are expensive ($700 to $1,500/ head).



The individual components soldered together to make a GPS data logger unit, plus the battery (blue) and the waterproof case it all goes into (red) before being strapped to a cow's neck.

I built a low-cost GPS data-logging collar from parts I found on the internet. A unit costs about $125, and I have built them so that the batteries last about 40 to 50 days. I tested them in the summer of 2017 out at the Hettinger REC, and they worked well (McGranahan et al., 2018).

Here I describe a full-bore roll-out of the DIY GPS collars at the CGREC in 2018. At any given time, we had about 40 units logging the positions of two to three cattle in each of our experimental pastures: the eight patch-burn grazing trials, the four continuously grazed refuge pastures, and the four pastures in the twice-over rotational grazing pastures.

The collars were on the pastures the whole time the cows were. We fit the collars when the animals were weighed and randomly assigned to pastures in mid-May, and the last collars came off when the cattle were moved off in mid-October.

A summer technician fits cow with a freshly duct-taped GPS unit in the field.

Taking GPS Collars from the Lab to the Field

The Brains of the Operation

That definitely was not me, or even Kevin. I'm talking about the ATSAMD21G18 ARM Cortex M0 microprocessor. This is a cheap but powerful little computer chip that is widely used by electronics and robotics hobbyists. As part of the open-source movement that seeks to make technology and information freely available to users without hefty licensing fees, an Italian group developed Ardunio, a simple system of electronics and computer code that lets users program simple sensors and data loggers.

I got my components from Adafruit Industries, a start-up in Brooklyn, N.Y., that sells small, portable Arduino electronics hardware aimed at hobbyists and artists. I soldered it all together in the lab on campus and re-wrote existing computer code available online to create a custom program to read GPS information at set intervals and store them on a removable SD (secure digital) card.

Deployment and Recovery in the Field

At the headgate, we plugged in a charged battery, sealed the waterproof case with duct tape and fastened the device to a triple-ply collar with hose clamps. We wrapped the cases in stretchy, insulated electrical tape for shock absorption, and we used lots of duct tape.

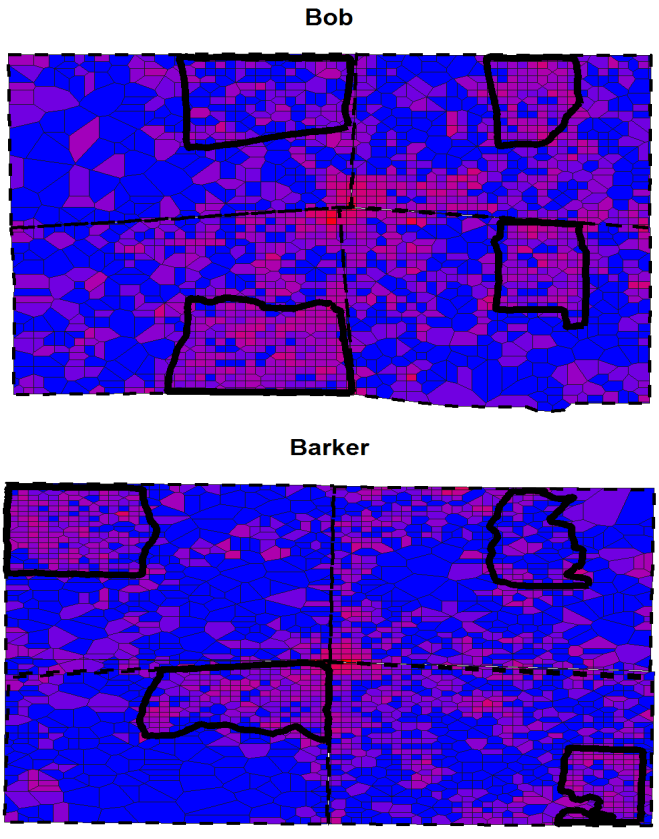
About monthly, Carl Dahlen's team ran the cattle through the chute, and we were there to swap out batteries, download data and replace any malfunctioning units.

Interpreting the Results

The GPS collars brought in a lot of data. By the end of the grazing season, I had nearly 10 million individual datapoints. So much information gives us an opportunity to look into how cattle choose where to graze based on ecological sites, distance to water and, of course, which grazing system they are in. We also have the opportunity to see how these decisions change throughout the season. As the plant community changes, or droughts come and go, do cows make different decisions on where and when they will graze?

For now, we can answer the simple question that got me interested in designing my own DIY system: Do cattle tend to concentrate their grazing in recently burned patches? It appears that they do, which is consistent with our observations that recently burned patches have higher-quality forage emerge after fire, which stays high quality throughout the season as long as cattle keep grazing it and maintaining a juvenile state in the grass sward.

But they also spend more time outside of the burned areas than cattle in the southern Plains do, which might be because our fires were more patchy and we have more cool-season grasses up here. Cool-season grasses generally are more palatable, even without having been burned.



An example of how GPS positions are used to understand cattle behaviour. The red zones are areas that collared cows spent a lot of time in through June 2018; very few positions were recorded in blue areas. Each image has four 160-acre pastures, and burned areas are outlined in bold. The water source is in the center. Cows were definitely attracted to burned areas, although not so much in Barker NE.

Conclusions

The DIY GPS collars worked pretty well at the CGREC. I'll admit I was pleasantly surprised, especially for as little as each unit cost (about $125). Thanks to a few cows with GPS collars, we were able to confirm that very often, cattle chose to graze in recently burned patches. Further analysis will reveal how grazing site selection decisions vary through the season, and research in additional years will provide more information as burning and precipitation patterns change.

Reference

D.A. McGranahan, B. Geaumont, J.W. Spiess. 2018. Assessment of a livestock GPS collar based on an open-source datalogger informs best practices for logging intensity. *Ecol. Evol* 8:11 5649–5660.