In Memoriam

Granite Mountain Hotshots

Though words from strangers are inadequate at times like this; we at the V Bar V Range Program want to express our deepest sympathy for the loss of the wildland firefighters in the Yarnell Hill Fire on June 30, 2013. Our prayers are with the families, friends, co-workers, first-responders, pastors, counselors and community members who will feel the grief long after the smoke and the media are gone. We appreciate and respect the hard work and sacrifice these brave individuals have made in serving our communities. We pledge to continue our efforts to conduct research and develop tools to make what you do out there on our wildlands, safer and more effective. Rest in peace.
Stress or disturbance - disturbance or stress?

In the ecological context, disturbance is regarded as an event of intense environmental stress occurring over a relatively short period of time and causing large changes in the affected ecosystem. Disturbance can result from natural causes or from the activities of humans. Science Encyclopedia

Stress is defined as an organism's total response to environmental demands or pressures. When stress was first studied in the 1950s, the term was used to denote both the causes and the experienced effects of these pressures. More recently, however, the word stressor has been used for the stimulus that provokes a stress response. One recurrent disagreement among researchers concerns the definition of stress in humans. Is it primarily an external response that can be measured by changes in glandular secretions, skin reactions, and other physical functions, or is it an internal interpretation of, or reaction to, a stressor; or is it both? Medical Dictionary

As I have been working through the process of my 5-year review this year, on a couple of occasions I have given some thought as to how I have worded my goals and objectives for the research portion of my job. The overall goals have not changed and they are very clear in my mind, but I don't think I have always communicated them clearly. On the extension side of things, my overall objective is straight forward and to the point:

To acquire, demonstrate, and disseminate useable information on sustainable management of rangelands to agricultural professionals, livestock producers, natural resource managers and the public.

Sub-objectives for extension include...

Youth: To educate K-12 science and agricultural students on the importance of rangelands and their contribution to agriculture and natural resources.

Adult: To educate agricultural producers and natural resource managers about practices related to ecologically and economically sound management of rangelands.

Easy to say; harder to do. Now let's compare the overall extension objective to that for research:

To explore the relationships between: 1) the physiology and nutritional ecology of grazing animals, 2) ecosystem disturbances such as drought and herbivory, and 3) to use the knowledge thus obtained to further the development of sustainable management strategies on rangelands.

And then to break it down further, I have the following sub-objectives...

Basic: 1) Elucidate mechanisms by which nutritional stress is manifest through the metabolic, immune, and endocrine systems in the hind gut and ultimately potentially detected in the feces of grazing animals, and 2) elucidate mechanisms by which ecosystem disturbances and their interactions affect the nutritional ecology of grazing animals.

Applied: 1) Develop and evaluate monitoring techniques for grazing animals and forage resources, and 2) develop and evaluate decision support systems for rangeland and natural resource managers.

So, if you didn’t think I was “disturbed” before, you probably do now. But don’t “stress” about it, let me explain. The two basic research subject areas I describe here at first may seem to be random selections, but upon closer examination are in fact related. One might consider a disturbance such as drought to be...
stressful to the ecosystem. Similarly, stress can be thought of as a disturbance to the homeostasis of an animal. Connecting the dots, stressing a rangeland ecosystem may reduce its productivity which will disturb the ability of herbivores to obtain shelter or nutrition. Archer and Stokes (2000) stated it this way:

“Ecological systems and the organisms which comprise them have evolved with and are a product of various stresses, perturbations, and disturbance regimes. However, in human-influenced systems, new disturbances and stresses may be introduced and the frequency, intensity and spatial extent of natural disturbances altered. Natural and anthropogenic disturbances invariably co-occur, so it becomes difficult to ascertain which may be the proximate cause of ecosystem change... An understanding of stress and disturbance will help resource managers to (1) mitigate anthropogenic disturbances which might threaten sustainability and lead to undesirable and potentially irrevocable changes in ecosystem processes and (2) increase chances for success in rehabilitating or restoring degraded ecosystems.”

Increasing the understanding of each of these subject areas will contribute to the successful long-term management of rangelands. We have conducted a few research projects, here at the V Bar V Ranch, and with collaborators over the last several years that were designed to examine various aspects of the relationships between stress and disturbance, land and animals. I thought you might be interested in hearing an update on some of these efforts.

Let’s start with a project looking at soil carbon and nitrogen in grazed versus “un-grazed” sites. In this study (Tolleson and Kava 2011) we collected soil surface samples from under shrub canopy, grass canopy, and interspaces in desert-shrub and piñon-juniper communities on or near the V Bar V. Within each of these vegetation types we also compared sites with relatively heavy livestock grazing (i.e. within ¼ mile of year-long water sources in pastures grazed by cattle for 14-21 days per year) to those with little or no livestock grazing for 10-20 years. Based on previous research, some of the results are what we would expect. For example, percent bare soil was higher in the grazed versus “un-grazed” sites. There was more litter, carbon, and nitrogen in the piñon-juniper than the desert-shrub sites, and carbon and nitrogen were greater under shrubs than under grass and, under grass than interspaces. An interesting result was that we observed a grazing by landscape position interaction for soil carbon and nitrogen. Under plant canopies, these nutrients were higher in the grazed sites than the “un-grazed” and for interspaces (i.e. bare spots) the opposite was true. We also measured a difference in soil microbial metabolism in that greater substrate usage occurred under plant canopies than interspaces (Figure 1). Our thought is that younger plant material in the grazed sites is providing higher quality (i.e. smaller C:N ratio) litter and a better nutritional environment for a diverse soil microbe community. Sort of a
Stress or disturbance - disturbance or stress? .....continued

combination of the intermediate disturbance hypothesis and the island of fertility concept. The trick then is to manage the level of disturbance (grazing) so that you optimize plant quantity and quality for the organisms above and below ground. I wonder if we can measure any such response from cows?

To address the ability of central Arizona rangeland in providing adequate quantity and quality of forage for cattle, we (Tolleson and Schafer 2010) applied fecal near infrared spectroscopy (FNIRS) and nutritional balance software to project body condition score (BCS; 1 = thin, 9 = fat) in mature Hereford and CGC composite (50% Red Angus, 25% Tarentaise, 25% Charolais) cows. Diet quality ranged from a minimum of 5.3% crude protein (CP) and 56.9% digestible organic matter (DOM) in January 2009 to a maximum of 14.6% CP and 62.9% DOM in August of 2008. During this time frame, forage quantity was adequate. Diet quality correlated with observed seasonal changes, elevation/vegetation type, and precipitation events. Across breed-types, the projected BCS averaged ~0.2 score different than observed BCS (Figure 2). The greatest difference in projected versus observed BCS occurred during periods of lowest diet quality (i.e. greatest stress?). This observation could be due to decreased accuracy of the FNIRS diet quality predictions at lower nutritional levels or, to an effect of nutritional stress on fecal chemistry as detected by NIRS. I wonder if the latter idea occurs with a stressor other than nutrition? A recent experiment in collaboration with USDA and TX A&M entomologists may help answer that question.

In a study conducted by Tolleson et al. (2013) we examined the effect of an infestation of cattle fever ticks (Rhipicephalus spp.) on FNIRS predicted diet quality in growing cross-bred beef steers. These ticks are the ones responsible for an estimated direct and indirect cost to the cattle industry of $130m yr⁻¹ during the late 1800’s and early 1900’s. Although eradicated from the US in 1943, they are still established just over the border in Mexico. In previous reports (Tolleson et al 2002) we observed that FNIRS predicted diet quality decreased with a Lone Star (Amblyomma americanum) tick infestation. In cattle fed the same diets we observed an increase in FNIRS predicted diet quality for R. microplus treated animals and very little change in predicted diet quality for those treated with R. annulatus versus non-infested controls. Differences in fecal spectra from the recent study are illustrated in Figure 3. If these differences continue to be observed in future studies, FNIRS could provide an early non-invasive detection method for identifying tick stressed animals (livestock and wildlife) that cross the border. And, this determination could be accomplished in the same samples that are analyzed for nutritional management. Future work will be directed at applying this technique in range settings and in determining if tick stressed cattle “use” a pasture differently than their non-tick
infested counterparts. I wonder if stressed animals could then be one indicator of a landscape in transition from one state to another? We will need more research to answer that one.

So, coming back full circle, if the soil in a disturbed landscape produces a different amount and quality of plants for cover or food, and if altered production affects animal health and performance, and if stressed animals not only are affected by, but also affect a landscape (i.e. disturb it?), doesn’t it make sense that all these factors are related? And if we are going to understand them to the level that we manage them better, more sustainably in the long run, doesn’t it make sense to study the interactions between these factors at various scales? The relationships between stress and disturbance, disturbance and stress? Sounds like integrated translational science to me.


Chris’ Hot Topic of Range: Ants in the Rimrock

“Go to the ant, thou sluggard; consider her ways, and be wise” ~ King James Bible

I was a tropical myrmecologist way back when, working on the ecology of exploding ants. That’s “ANTS”...Doug likes to throw that out as a conversation piece in public settings, but it all gets muffled up and bogged down in his Texas drawl. This means that instead of repeating old stories of hypertrophied mandibular glands and ruptured gasters, I end up spending the night talking about exploding “hands”; so the joke’s on him. Oddly, I think he’s okay with that.

Well we don’t have exploding ants here, but we do have bragging rights. Arizona is known as the state with the largest diversity of ants in the nation, with 43 genera and over 300 native species. On our rangelands, the most conspicuous of these ants are the harvester ants of the genus *Pogonomyrmex* (Pogos). These are the pebble mound building large red ants that sometimes get the better of you if you don’t watch where you stand (Figure 1). We often ignore them, with the more mischievous of us playing demolition on their nests, but they can have a large impact on the landscape.

For one, they are a form of disturbance. Nests can be large with a cone shaped pebble mound focused at the center. These pebble mounds are built by excavating and foraging pebbles that fit a specific design, and can represent a large redistribution of soil particle size. One purpose of these mounds seems to be for thermal regulation. For Pogos that build a respectable pebble mound, the longest slope and nest entrance face the southeast. As the mound warms up they relocate themselves and their brood up or down the cone to optimize performance and brood production. I’ve found that this behavior typically means that the west side of their vegetation cleared disk is patrolled last in the morning, making this soft completely flat space the perfect place to set up a sleeping bag for the night. Just be sure not to roll into the pebble mound, or sleep in too late. That could be painful as Pogos are known to be the most poisonous insects in the world.
That disk may start out small, but as the colony matures and grows in strength they may clear a disk ≤ 18 ft. across (Figure 2). Pogo colonies can live from 15 to 50 years, making these disks a long term feature on the landscape. Nobody’s really sure why the Pogos need such a large cleared area, but speculation includes reduced transit time for foragers, reduced risk to predation, increased exposure to solar radiation, or a desire to be firewise. I personally think it has to do with converting a three dimensional battleground into a two dimensional battleground for defensive purposes, but the actual reason is probably a combination of all these factors. Now one nest clearing of a single disk is a rather small disturbance, but where there’s one nest there are usually more and the literature reports maximum densities ranging from 8 to 60 nests per acre. This typically translates to about 1 to 8% land cover, though there are cases where Pogo land cover is extreme (one site in Oregon recorded up to 18% land cover). I searched Google Earth and did find some nest densities over 8 per acre, but that only counted nests big enough to see by satellite (Figure 3). So our rangelands can have some decent densities.

At these larger nest densities granivory becomes a major form of disturbance. Most granivory takes place up to 32 feet from the nest, but it can extend up to 80 ft away. In this area the ants harvest as many seeds as they can find. For most plants this equates to ≤ 10% of their annual seed production. However, Pogos can have a rather persnickety palate, and if a plant is particularly choice the Pogos may harvest the seeds before they’ve had a chance to mature and fall. In those situations Pogos are known to harvest a substantial percentage of annual seed production, reaching up to 100% on those seeds considered most delectable. The result is a rangeland-wide manipulation of vegetation distribution.

All this disturbance may make Pogos seem like a rangeland pest, but they provide many ecosystem benefits. Pogo nests are nutrient islands, much richer than nutrient islands created by shrubs and grasses. They also have higher water infiltration rates and have been found to have higher soil moisture content than surrounding soils. The higher nutrients, higher soil moisture, and mock allelopathy from the vegetation cleared disk all combine to create an edge effect that benefits any plant lucky enough to germinate along the disk’s margins (see the dark ring in Figure 2). Our plant of the “week,” Indian Ricegrass, is particularly good at being lucky. It, along with some needle grasses, seems to have an ant/plant relationship that causes it to grow along disk margins more frequently than other plants.

The disk’s edge effect has two more ecosystem benefits. You might have guessed that the barren disks can
reduce forage availability, but that is largely mitigated by the increase in biomass provided on the disk margins. The actual net loss of forage due to ant activity may be minimal. In fact the healthier more robust vegetation along margins may have an increased tolerance to grazing. This can also translate to drought resistance. Margin plants have access to higher soil moisture and may have built stronger root reserves providing greater fitness. So while a severe drought may be a huge cause of plant mortality, these margin plants can survive and be a critical seed source for recolonizing the rangeland.

So the next time you see a *Pogonomyrmex*, stop and admire her work. She might get under your skin a time or two, but the ecological services make up for it.
Plant of the “week” by guest writer Martin Esplin

A Productive and Useful Plant with Varied Benefits:
Indian Ricegrass - *Achnatherum hymenoides*

Indian Ricegrass species is a perennial bunch grass native to the rangelands of Western North America. The range of this grass is from British Columbia, Canada to Northern Mexico and from Texas to California. It is an endangered species in Minnesota. It grows in arid and semi-arid areas receiving 8 to 14 inches of precipitation annually at elevations of 3,300 to 9,500 ft. It is a drought tolerant plant and can grow in areas that receive as little as six inches of precipitation annually if seeded in such regions. Indian Ricegrass grows best in sandy, course soils that are well drained. It is not tolerant of fire, but will repopulate from seed after fire. Other plant species growing in regions where Indian ricegrass is found are needle and thread, Sandberg bluegrass, bottlebrush squirreltail, sagebrush, winterfat, and shadscale.

Indian Ricegrass grows to a height of 12 to 20 inches. When mature, the seed heads have a panicle arrangement with each seed attached to a hair-like branch. The seeds are covered by a white hairy hull and when outside this covering they are dark brown or black. The leaf blades are tightly rolled giving them a slender stem-like appearance. Its fibrous root system makes it ideal for erosion control and use for reclamation efforts. Indian ricegrass requires full sunlight, not thriving in shaded areas and does not compete well during establishment with introduced aggressive grasses.

Few seeds of native grass species have the characteristics comparable to domestically grown grains. The seeds from Indian Ricegrass can be milled to make flour; several Native American tribes of the West harvest the seeds for a food source. The Apache, Goshute, Havasupai, Hopi, Kawaiisu, Navajo, Paiute, and Zuni tribes have all been known to use Ricegrass in their diets. The plant is high in protein, making it highly valuable as forage for livestock and wild ungulates. Birds and rodents also use the substantive grain-like seeds for feed.

The seeds can remain dormant for up to four to six years before germinating. This trait delays the species ability to reproduce, but also makes it drought tolerant. Seeds that have been scarified tend to germinate better than those that have not been marked or scratched up. For successful plant reproduction, seeds are best planted in the fall season. Ideal winter conditions for the seeds are in soil that is moist and cold at a temperature of 38-40 degrees Fahrenheit. They spout in early spring and
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**Plant of the “week”...continued**

grow through the summer. Indian Ricegrass puts out its seeds at the latter end of spring, at which time it is best not to graze this grass. In early spring and during the winter, moderate grazing benefits Indian Ricegrass so long as it is given adequate time to recover while moisture is available. In the late fall and winter, its base remains somewhat green and is palatable throughout the year making it good forage for grazing animals.

Photo by Martin Esplin, University of Arizona, Arizona Cooperative Rangeland Monitoring Program

Distribution of Indian Ricegrass, *Achnatherum hymenoides* (ACHY)

USDA, NRCS. 2013. The PLANTS Database
NIRS activity winners at NRCWAY

Congratulations to Team 2; winners of the grazing animal nutrition/ecology NIRS activity at NRCWAY last week.

The winning score was a ratio of 1.13 (2.26/2.00), and their animal was the mature bull elk or buck deer. Below are the instructions for the activity. How well do you think you could do?

Pretend you and your team are one of the ungulate herbivores listed below, living in this mid-elevation ponderosa pine habitat. Your current daily nutritional requirement for N (% of daily intake) is: (each team had a different animal with a different requirement, i.e. Mature bull elk or buck deer with growing antlers - 2.0%, Growing range beef steer - 2.8%, etc...).

Step 1. As a team, select your home range. Your home range must be located within a ~200 yd radius of this site but for the activity, must be confined to a ~50 yd circle.

Step 2. Using the clippers, spring scales, and the plastic bags provided; select and sample a diet which most closely meets your assigned animals requirement consisting of 5 different plants (~20g each), including at least 1 grass, 1 forb, and 1 woody species.

Step 3. After 30 minutes, bring your sample to the starting point to be analyzed by the portable NIRS instrument and laptop computer.

The team with the ratio of required to selected % N closest to 1.0 wins (e.g. 2.25 required /1.97 selected = 1.14).

AZ Section SRM Summer Meeting

“Babbitt Ranches Land Ethic & Tour of the CO Bar Ranch”
August 7-9, 2013
Flagstaff
The view from the Rim

Even after 5 years in Arizona, I still at times say something that will make people just look at me, shake their head and say “where are you from?” So, I thought I should offer a few example Tolleson-isms and their translations.

* “That ol’ boy don’t know ‘come here’ from ’sic-em’...”

It would appear that the gentlemen in question, does not possess adequate knowledge, skills and abilities to perform in this situation.

* “That dog won’t hunt...”

I am sorry kind lady, but I happen to disagree with you on this particular point.

* “I’m hell when I’m well, and I’ve never been sick...”

Yes, you are correct; I am an egotistical arrogant @#$%&!!...

Just me talking...

Click here to view video