Western Confluence

Winter 2014 Issue 01

NATURAL RESOURCE SCIENCE AND MANAGEMENT IN THE WEST

The Bird that Brought the West Together

Cattle as Ecosystem Engineers

The Ecology of Fear

A publication of the Ruckelshaus Institute, a division of the University of Wyoming's Haub School of Environment and Natural Resources

Cattle as ecosystem

New grazing management enhances rangeland biodiversity

By Justin D. Derner, David J. Augustine and Emily J. Kachergis

Climate, soils, topography, grazing, and fire have shaped the composition and structure of vegetation on rangelands in the American West. Collectively, the many possible combinations of these different factors should lead to diverse plant communities and associated diverse wildlife species. Differences in vegetation structure (i.e., how tall above the soil surface the plants are) and composition (kind and amounts of different plants) are both important for biodiversity.

Yet, many rangelands across the American West have been managed through similar grazing management practices so that extensive areas of vegetation have comparable kinds and amounts of plant species (e.g., same grasses, forbs and shrubs; vegetation composition). As a result, the lack of many different plant communities can result in few differences in height of vegetation (or vegetation structure), which are often needed by grassland birds. This lack of vegetation diversity can translate to a lack of habitat diversity and biological diversity on these lands.

Rangeland plant communities often appear uniform or unvaried due to the fact that ranchers have an economic incentive to graze their livestock using management practices that emphasize "management to the middle" and "avoidance of the extremes." These management practices are sustainable for livestock production,[1, 2], as they optimize both weight gain per animal and per acre. Producers have an economic incentive to effectively use available forage and convert it to pounds of weight gain as the well-established market-driven system emphasizes price per pound. However, the resulting "sameness" of vegetation composition and structure, due to the application of similar management across large land areas, has triggered the demise of many grassland birds as well as reduced biodiversity. As a result, many of the "species of concern" on rangelands of the American West live on landscapes that have little variation of vegetation composition and structure. For example, the mountain plover, adapted for breeding on bare ground, and the lark bunting and western meadowlark, adapted for high cover areas, have been declining on semiarid rangelands.

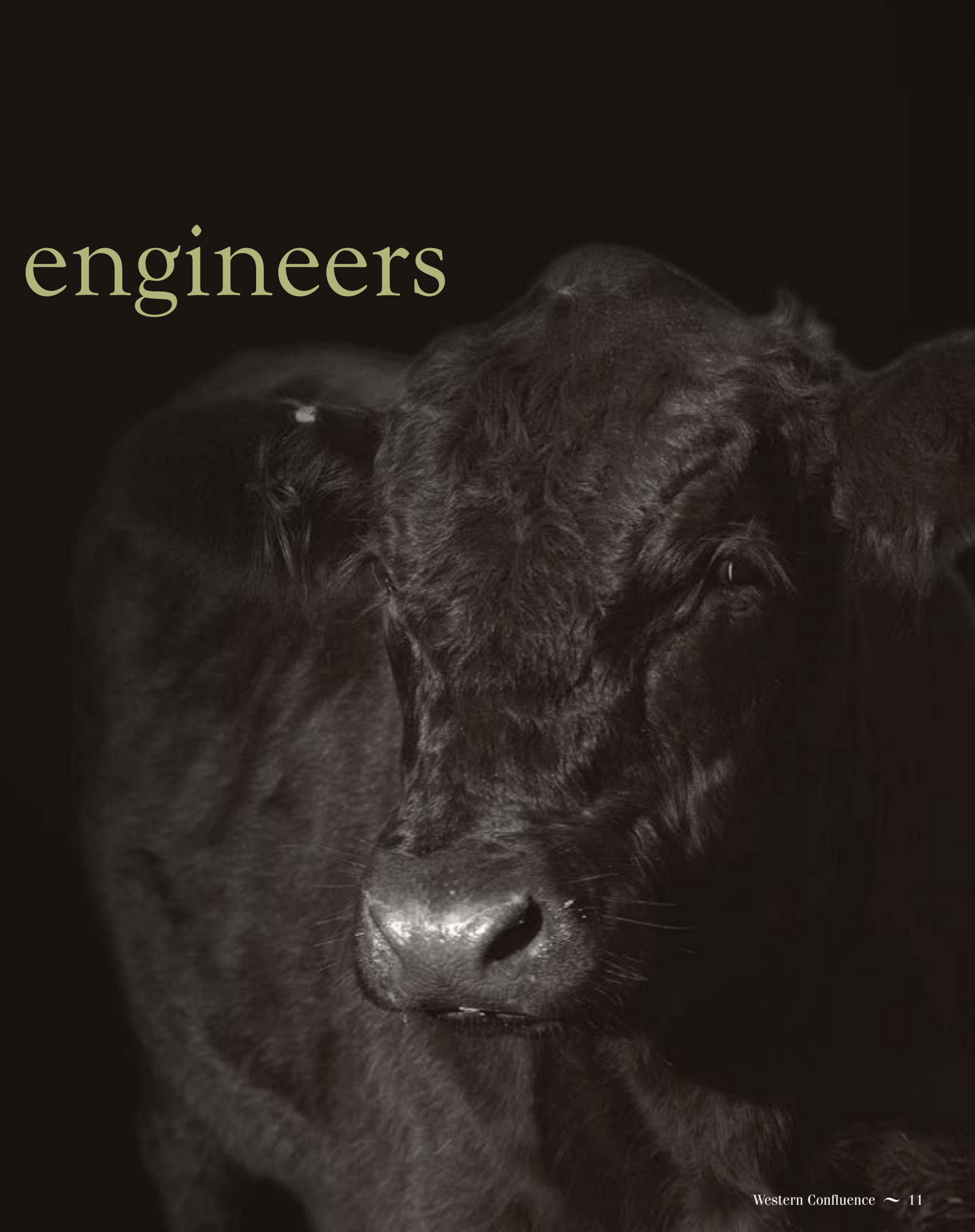
Incentivizing ranchers to increase differences in vegetation composition and structure on rangelands of the American West will require 1) understanding how livestock can be used as tools to engineer rangelands for *both* provision of ecosystem goods (e.g., livestock production) and services (e.g., wildlife habitat, water quality and quantity, soil health, carbon sequestration and storage), 2) determining ecosystem services' economic values, and 3) creating proper economic incentives that will foster vegetation—and greater biological—diversity.

MANAGING FOR DIVERSITY

What is vegetation heterogeneity? Livestock can engineer rangelands to produce differences in vegetation structure and composition. For example, intensive grazing in one area may result in higher amounts of bare ground, which benefits species such as the mountain plover. Resting a nearby area will allow the forage to grow taller, providing nesting habitat for grassland species such as the pintail, or in sagebrush, the sage grouse. This alternative approach to management increases percentages of the landscape with short and tall vegetation structure. Possible tradeoffs with livestock production merit additional investigation to provide economic valuations for the "costs" of providing vegetation heterogeneity.[3]

Livestock can engineer differences in vegetation structure and composition within the framework of most current management practices. For example, ranchers can alter timing and intensity of grazing, length of rest periods, and type of livestock to create different levels in height of vegetation and kind and amount of plants. Ranchers can control when livestock graze certain areas, for how long, and how much vegetation is left ungrazed (to a certain height or residue level) following a grazing period. Through management decisions, ranchers vary the length of rest periods from relatively short (weeks-months) to long (one year or greater). Longer rest periods stockpile forage resulting in greater vegetation heights.

engineers



Varying the time of grazing across years or stocking rates can shift vegetation composition. Combining different types of livestock, such as cow-calf pairs, yearlings, sheep, goats, or combinations of these, can strategically engineer the vegetation on rangelands due to different diet selections.

Combining grazing with prescribed fire in the Great Plains portion of the American West modifies the amount of bare soil, forage quality and quantity, vegetation structure and, in some cases, reduces unwanted species, such as prickly pear cactus or broom snakeweed (dry areas) or smooth brome (tallgrass prairie).[4, 5] Burning patches within pastures encourages livestock to graze recently burned areas where forage quality is higher. In addition, less grazing activity will occur in the non-burned parts of the pastures, which results in more vegetation structure. This creates a greater range of vegetation structure in pastures with patch burns, compared to those pastures managed similarly but without prescribed fire. Combining fire and grazing in the Great Plains, does not, however, consistently create vegetation heterogeneity.[6] Sites where the combination works effectively are those where fire is the primary driver of livestock grazing behavior, such as the tallgrass prairie. In addition, some invasive plant species, such as cheatgrass in the Great Basin and Lehmann lovegrass in the Southwest deserts, thrive following burns, so inclusion of fire as a management tool without consideration of the inherent risks associated with increasing vegetation heterogeneity in these ecosystems is not recommended.[7] For these rangeland ecosystems of the intermountain west and desert southwest, fire can result in 1) large-scale conversions of native plant communities to invasive plants, and 2) altered fire regimes with fires becoming more frequent.

Taller vegetation can be attained by grazing an area and then not coming back to graze again for an extended period. For example, rest periods greater than one year generally result in taller vegetation structure due to an absence of grazing. However, this requires some flexibility in the livestock enterprise to accommodate this strategy. Livestock and vegetation management require flexibility to incorporate prior use patterns, and current and near-future grazing plans, into the overall management plan. This flexibility can involve using livestock as ecosystem engineers by putting more animals on a unit of land area, but for a shorter time. This will decrease the selectivity of grazing animals but increase the uniformity of grazing, as well as dung and urine deposition within a pasture, but with an overall objective of creating differences among pastures and across years. Grazing animals for a shorter time period, in different times of the year and sequences across years will increase differences in vegetation composition and structure. Temporary electric fencing can subdivide existing pastures to provide more control of livestock grazing for these shorter time periods of grazing and longer periods of no grazing.

Photos representing vegetation heterogeneity created by engineering rangelands using livestock through differences in season and intensity of grazing in shortgrass steppe. Areas with high bare ground and limited plant cover were created by very heavy grazing in early spring (upper left), heavy grazing in summer created areas of very short structure (lower left), light grazing in the winter resulted in saltbush-dominated vegetation with more diverse vegetation structure (upper right), and diverse forb and grass species are enhanced with light grazing during the summer (lower right).[16, 17, 18, 19, 20]

ECOSYSTEM SERVICES AND LIVESTOCK PRODUCTION

Achieving both provision of ecosystem services and maximal livestock production at the same time on ranches is difficult. On one hand, there is high demand to increase production of livestock to feed an ever-expanding world population.[8] On the other hand, there is growing societal desire for rangelands to provide a suite of ecosystem services.[9] Fundamental to these challenges is the stark reality

that a developed economic market system drives livestock production whereas markets have yet to emerge for ecosystem services. The benefits of providing these services have yet to be monetized. Moreover, ranchers fear economic costs if they use livestock as ecosystem engineers such as lower livestock weight gains. For example, patch burning in pastures can provide greater heterogeneity of vegetation structure with no effects on livestock weight gains compared to pastures not burned,[10] but there are costs and risks to ranchers to incorporate these prescribed burns. Without incentives that compensate for this lost income, or developed markets for ecosystem services on which decisions could be made to modify management to emphasize additional outcomes that have economic rewards, this issue will remain problematic for ranchers. Preliminary efforts are unfolding in the western U.S. that may serve as a template for additional development of ecosystem service markets.[11, 12]

We are not suggesting that all current grazing management switch from a livestock production-centric basis to one that emphasizes provision of vegetation heterogeneity. Rather, judicious approaches that take advantage of pre-existing templates of heterogeneity of soils or topography can start the process. Changes in grazing management should take into account: 1) potential of different ecological sites to produce differences in vegetation, 2) determination that vegetation/habitat diversity is a desired outcome for management, 3) flexibility in the enterprise to accommodate modifications in grazing management, and 4) realization that there may be some tradeoffs associated with livestock production for certain aspects of this approach.

ECONOMIC INCENTIVES

Ranchers can use livestock to engineer landscapes for provision of *both* ecosystem goods and services,[13, 14] and this approach can be implemented on many rangelands, provided there are developed markets that value ecosystem services to determine economic returns associated with their decision-making. Given the current reality in which formal markets exist only for livestock weight gains, it is not surprising that management practices and associated decision-making processes are driven to maximize livestock production.[15] This has led to increasing the "sameness" of vegetation composition and structure on landscapes through "management to the middle," rather than management which embraces a much larger range in both vegetation composition and structure.

"Engineering" for greater vegetation heterogeneity will occur when markets for ecosystem services provide economic justification for ranchers to change management. Providing economic markets for these ecosystem services, and associated economic values for these services, are the nexus for facilitating more widespread engineering by livestock of rangeland ecosystems in the American West. Ranchers, land managers, policy makers, economists, and others need to come together in confluence to create proper economic incentives that will foster changes in management practices to increase vegetation heterogeneity and produce marketable commodities from these rangelands. Then, development of markets to place economic value on these commodities for the rancher, as well as for the general public, should provide the foundation on which to foster more engineering of rangeland vegetation by livestock.

Dr. Justin D. Derner *is a Rangeland Scientist for the USDA-Agricultural Research Service Rangeland Resources Research Unit in Cheyenne, Wyoming. He currently serves as co-Lead Scientist for the project entitled "Improved Management to Balance Production and Conservation in Great Plains Rangelands."*

Dr. Emily J. Kachergis *is a Landscape Ecologist and AIM-Monitoring Implementation Lead with the National Operations Center of the Bureau of Land Management in Lakewood, Colorado.*

Dr. David J. Augustine *is a Research Ecologist for the USDA-Agricultural Research Service Rangeland Resources Research Unit in Fort Collins, Colorado. David is also a co-Lead Scientist for the project entitled "Improved Management to Balance Production and Conservation in Great Plains Rangelands."*

ENDNOTES

1 Bement, R.E. 1969. A stocking rate guide for beef production on blue-grama range. *Journal of Range Management* 22:83-86.

2 Hart, R.H., and M.M. Ashby. 1998. Grazing intensities, vegetation, and heifer gains: 55 years on shortgrass. *Journal of Range Management* 51:392-398.

3 Derner, J.D, J.K. Detling, and M.A. Antolin. 2006. Are livestock weight gains affected by black-tailed prairie dogs? *Frontiers in Ecology and the Environment* 4:459-464.

4 Augustine, D.J., and D.G. Milchunas. 2009. Vegetation responses to prescribed burning of grazed shortgrass steppe. *Rangeland Ecology and Management* 62:89-97.

5 McGranahan, D.A., D.M. Engle, S.D. Fuhlendorf, S.J. Winter, J.R. Miller, and D.M. Debinski. 2012. Spatial heterogeneity across five rangelands managed with pyric-herbivory. *Journal of Applied Ecology* 49:903-910.

6 McGranahan, D.A., D.M. Engle, S.D. Fuhlendorf, S.J. Winter, J.R. Miller, and D.M. Debinski. 2012. Spatial heterogeneity across five rangelands managed with pyric-herbivory. *Journal of Applied Ecology* 49:903-910.

7 Brooks, M.L., and J.C. Chambers. 2012. Resistance to invasion and resilience to fire in desert shrublands of North America. *Rangeland Ecology and Management* 64:431-438.

8 Food and Agriculture Organization of the United Nations (FAO). 2011. The state of the worlds' land and water resources for food and agriculture. Rome, Italy. 47 p.

9 Havstad, K.M., D.P.C. Peters, R. Skaggs, J. Brown, B. Bestelmeyer, E. Frederickson, J. Herrick, and J. Wright. 2007. Ecological services to and from rangelands of the United States. *Ecological Economics* 64:261-268.

10 Limb, R., S. Fuhlendorf, D. Engle, J. Weir, R. Elmore, and T. Bidwell. 2011. Pyric-Herbivory and Cattle Performance in Grassland Ecosystems. *Rangeland Ecology and Management* 64:659-663.

11 Cheatum, M., F. Casey, P. Alvarez, and B. Parhurst. 2011. Payments for Ecosystem Services: A California Rancher Perspective. Conservation Economics White Paper. Conservation Economics and Finance Program. Washington, DC: Defenders of Wildlife. 65pp.

12 Goldstein, J.H., C.K. Presnall, L. Lopez-Hoffman, G.P. Nabhan, R.L. Knight, G.B. Ruyle, and T.P. Toombs 2011. Beef and beyond: Paying for ecosystem services on Western US rangelands. *Rangelands* 33(5):4-12.

13 Derner, J.D., W.K. Lauenroth, P. Stapp, and D.J. Augustine. 2009. Livestock as ecosystem engineers for grassland bird habitat in the western Great Plains of North America. *Rangeland Ecology and Management* 62:111-118.

14 Toombs, T.P., J.D. Derner, D.J. Augustine, B. Krueger, and S. Gallaher. 2010. Managing for biodiversity and livestock. *Rangelands* 32(3):10-15.

15 Dunn, B.H., A.J. Smart, R.N. Gates, P.S. Johnson, M.K. Beutler, M.A. Diersen, and L.L. Janssen. 2010. Long-term production and profitability from grazing cattle in the Northern Mixed Grass Prairie. *Rangeland Ecology and Management* 63:233-242.

16 Knopf, F. 1996. Prairie legacies - birds. Pages 135-148 *in* F. Samson and F. L. Knopf, editors. *Prairie conservation: Preserving North America's most endangered ecosystem*. Island Press, Washington, DC.

17 Derner, J.D., W.K. Lauenroth, P. Stapp, and D.J. Augustine. 2009. Livestock as ecosystem engineers for grassland bird habitat in the western Great Plains of North America. *Rangeland Ecology and Management* 62:111-118.

18 Augustine, D.J., D.T. Booth, S.E. Cox, and J.D. Derner. 2012. Grazing intensity and spatial heterogeneity in bare soil in a grazing-resistant grassland. *Rangeland Ecology and Management* 65:39-46.

19 Augustine, D.J. 2011. Habitat selection by mountain plovers in shortgrass steppe. *Journal of Wildlife Management* 75(2):297-304.

20 Augustine, D.J., and J.D. Derner. 2012. Disturbance regimes and mountain plover habitat in shortgrass steppe: large herbivore grazing does not substitute for prairie dog grazing or fire. *The Journal of Wildlife Management* 76(4):721-728.

CONSERVATION GRAZING: RANCHERS LEAD THE WAY

Dave Powell, USDA Forest Service, Bugwood.org

By Emilene Ostlind

On the Howell Ranch and adjacent properties in western Colorado, cattle are used to create prime elk hunting opportunities. Managers carefully consider elk movements when they design the annual grazing plan for the ranch. In May and June they keep cattle away from elk calving grounds. Then the ranch hands concentrate cattle in favorite hunting spots in the first half of the growing season, and move them to other areas later in the summer, letting forage recover. When fall rolls around, those elk hunt areas are thick with new grass full of protein and energy.

"The elk appreciate that and have learned that. During the fall, in terms of grazing patterns, they tend to concentrate on areas grazed early," said Jim Howell, CEO of Grasslands LLC, and heir of the Howell Ranch. "The numbers are higher than ten years ago before we implemented it. There are almost too many elk."

The increased elk numbers are just one example of wildlife benefitting from new and improved management at the Howell Ranch. In an uncommon example of wide-scale ecosystem engineering, Howell and his team have made gradual, large-scale changes to how they move cattle through this and other ranches, and by their count they have successfully improved forage, biodiversity, and notably, livestock productivity. Scientists, however, who have studied "rotational grazing"—one term for the kind of practice Howell has implemented—have been unable to measure the benefits ranchers like Howell claim.

The Howell Ranch on Colorado's arid western slope spans deep, rocky canyons. When the ranch was managed using traditional grazing practices, cows roamed large pastures for extended periods throughout the year. They tended to concentrate along streams, munching fresh sprouts of plants trying to recover from recent grazing. Meanwhile, they never reached the bunch grasses high on the steep, forested slopes.

Under new practices implemented by Howell, ranch managers fence cross sections of the canyons about 600-800 yards wide with portable electric fences running from ridgeline to ridgeline. This creates a level of stock density that motivates the cattle to climb the slopes in a way they never did under low density, continuous grazing. As Howell describes it, on the first day the cattle graze along the creek bottom. Then they start climbing the slopes. They readily move up into the forest and by day two of a grazing period many cattle have reached the ridgelines. After three to five days, the managers move the cattle to the next fenced pasture.

Cattle also replace fire as a management technique on the Howell Ranch. Whereas some managers use fire to clear out decaying vegetation and trigger a flush of recovery, the Howell Ranch achieves that with cattle. Fire is too dangerous in western Colorado, and takes a lot of work to carefully burn even a small area. Instead, focused intensive grazing creates localized patches of regrowth attractive to wildlife and develops a mosaic of vegetation ages across the ranch.

Howell has ranched, consulted, and traveled in Argentina, Australia, Zimbabwe, South Africa, and New Zealand. In the mid 90s he and his wife, Daniela, managed the 34,000-acre High Lonesome Ranch near Lordsburg, New Mexico, where they deepened their management experience. When Howell and his wife moved back to their family ranch, they started to adjust grazing patterns. The switch from traditional to conservation grazing didn't happen all at once, but was gradually implemented season-by-season and year-by-year.

"The most important step is to get the mental shift to observer of ecology and animal behavior," said Howell. "You have to have managers on the ground with a research bent. They think in the abstract. They are not just strict cowboys."

That intellectual shift was the hard part, according to Howell. The infrastructure costs amounted only to grazing planning charts and a few reels of portable electric fence. Patience, trial and error, and gentle treatment helped the cows break old habits and learn new grazing patterns.

Howell's work in western Colorado is just one example of an outfit adopting altered grazing management and seeing benefits in grass production and habitat. Rotational grazing, as it is sometimes called, has been applied in the United States for about 45 years, and has become more sophisticated and widespread as decades pass.

The November 1969 issue of the American Society of Range Management's journal introduced the concept of intensive, short-duration grazing to North America. Range managers in Zimbabwe (then Rhodesia) were exploring the method. The idea was to concentrate livestock into small pastures and move them frequently. The paper's author, Sid Goodloe, wrote, "I saw ranches (in Africa) where existing fences had been stripped of one or two wires and those wires strung from tree to tree to divide pastures until the increased carrying capacity brought in enough money to build permanent fences."

Short-duration grazing, Goodloe wrote, "breaks the parasite cycle, puts the standing dry grass (top hamper)

Tim McCabe, USDA NRCS

down to litter, eliminates trails to and from water and chips the soil surface for better seed germination." Most importantly, ranchers applying the practice claimed they were able to reverse rangeland degradation even as they increased livestock numbers. Livestock would make better use of the available forage, according to proponents, and rangelands had time to grow back after each period of intense grazing. Ranchers could then raise more livestock on the same piece of land. Ranchers in Zimbabwe were enthusiastic that these new methods might help reverse deterioration of rangelands caused by long-duration or continuous livestock grazing. "The ranchers argued that results were plainly visible and that they couldn't wait for years of research," Goodloe wrote.

After publication of this paper, U.S. ranchers began to apply the practice with equal enthusiasm and results. It has gone by different names—short-duration grazing, holistic rangeland management, rotational grazing, conservation grazing. Many ranchers who have adopted rotational grazing, like Howell, swear by it. They say it has improved grass production and habitat diversity, repaired damaged streams, and reversed rangeland degradation. Many can share anecdotes of wildlife—from sage grouse to elk and from beavers to songbirds—returning to areas where they'd been absent for decades. And ranchers also claim they are able to increase stocking rates with rotational grazing because the animals have better access to more nutritional forage.

When Wayne Fahsholz started running the nearly-475,000-acre Padlock Ranch in the early 2000s he implemented what he calls a controlled grazing system. Electric fences keep cattle bunched in smaller pastures, and the animals are moved frequently—every few days to every few weeks. Fahsholz picked up these practices from working on other ranches and from attending the Ranching for Profit School, a program that teaches ecology alongside finance and grazing management.

"We have some massive spreadsheets," Fahsholz said. "Every two weeks our cowboys turn in an inventory of cows, the amount of supplement the cows used, what pastures they have used, and how many cows were in that pasture." That information is entered into a database and used to ensure that the same pastures don't get grazed too often, too long, or at the same time of year for consecutive years. In the winter the managers look at pasture conditions and correlate that to how many cattle were in each pasture at a given time of year, and for how long. They set up guidelines for the coming grazing season, but rely, too, on cowboys looking at pasture condition and deciding when the cattle need to move

on. "It's not an exact science," Fahsholz said.

But while ranchers extol the benefits of the practice, scientific studies have measured none of the proclaimed improvements to rangelands and livestock productivity. Despite claims of improved rangelands from ranchers, scientists who began to study rotational soon after Goodloe's paper was published have arrived at startling results. Controlled studies of rotational grazing have been unable to detect the benefits ranchers describe. Numerous studies over the decades measured reduced infiltration of precipitation into soils, no change in forage production, declined ecological condition of ranges, and lower livestock productivity.

These studies have teased apart the separate influences of grazing duration and stocking rates. One review, published in 2000 and authored by Jerry Holcheck and four others, scrutinized efforts by researchers at 13 locations in North America to validate short-term rotational grazing effects on plant succession, mineral cycling, water filtration into soil, and other purported benefits. The review stated:

- Hoof action from having a large number of animals on a small area for short time periods reduced rather than increased infiltration
- Short-duration grazing increased erosion compared to continuous or season-long grazing
- There is little difference in forage production between short-duration and continuous grazing systems if stocking rates are the same
- Short-duration grazing [was] similar to continuous grazing in effects on plant succession and range condition if stocking rates were the same

Several studies showed that livestock didn't gain weight as fast under short-duration rotational grazing as compared to continuous grazing, while other studies showed no difference and one study showed livestock gained extra weight with rotational grazing

A major study by W.A. Manley and five coauthors, cited in the above review, analyzed both grazing duration and stocking rates, and measured the effect of each on surface and underground biomass, plant species composition, and groundcover from 1982 to 1994 in southeast Wyoming. The researchers created a matrix of study plots and, for the 12 years of the study, assigned each plot a grazing strategy (continuous, seasonally deferred, or short-duration rotational grazing) and a stocking rate (from light at 0.16 steers per hectare, to heavy, 0.56 steers per hectare).

The researchers found that under heavier stocking rates—that is, with more livestock per acre—native grasses decreased and forbs increased over the years of the study, regardless of grazing strategy. They also found that steers gained less weight per hectare of land when they were heavily stocked compared to plots with fewer steers per hectare.

Rather than informing management practices, such findings have ignited controversy between advocates of rotational grazing (and the ranchers who believe it works) and ecologists who argue that increasing stocking rates come with no ecological benefit. Holcheck, author of the above review, wrote in his conclusions, "History shows that it's human nature to believe a good story rather than pursue the truth," adding his claim that *only* reducing stocking rates could help rangelands recover from decades of abuse. He even attributed financial losses experienced by ranchers in the 90s and growing conflict between ranchers and environmentalists to high-risk management strategies involving high stocking rates.

Justin Derner and his colleagues are among the ecologists starting to tease apart these discrepancies and understand from a scientific perspective how grazing can be used as a tool to improve the ecological health of rangelands. In a 2011 paper in *Rangeland Ecology and Management* titled "Origin, Persistence, and Resolution of the Rotational Grazing Debate: Integrating Human Dimensions Into Rangeland Research," Derner and five co-authors listed variables rangeland scientists may not be accustomed to accounting for in their experiments: ranch managers' goal setting, experience, and decision making. They wrote

> The scientific evidence refuting the *ecological* benefits of rotational grazing is robust, but also narrowly focused, because it derives from experiments that intentionally excluded these human variables. (Emphasis original.)

The authors argue that a rift exists between the piercing scrutiny of highly controlled scientific study and the broader reality of natural resource managers continually adjusting their prescriptions. The authors call for recognition of the limits of scientific knowledge as applied to management of such complex natural resource subjects as rangeland ecosystems, and propose developing a new model by which research of such ecosystems can account for human dimensions when measuring management practices.

In another paper ("Livestock as Ecosystem Engineers for Grassland Bird Habitat in the Western Great Plains of North America," *Rangeland Ecology and Management*, 2009), Derner and three different co-authors describe, much as in the accompanying feature article, methods for managing grazing to promote diverse rangeland vegetation. Moving beyond electric fences to control livestock movement, the authors recommend placing supplemental feed and water and herding as methods to get cattle to graze some areas more heavily than others, thus creating a mosaic of vegetation of different ages and heights. Such approaches, they say, can help rangeland managers achieve both conservation and production and offer an alternative to ending public lands grazing for conservation purposes.

Meanwhile, no one is measuring "biodiversity" on rangelands to test whether new practices are reversing loss of species. Ranchers and the BLM measure grass production, usually by measuring grass heights and other metrics. Wildlife agencies and some conservationists monitor rangelands for target species (such as sage grouse) or count plant species and abundance.

On the Howell Ranch regular monitoring transects prove that plant diversity and ground cover have improved with the new practices. Active monitoring of wildlife biodiversity isn't happening, but Howell said, "Whenever you are enhancing plant diversity, that

opens niches for all kinds of wildlife from insects to birds to mammals." Anecdotally, such as with the elk hunting successes and sage grouse monitoring projects on other Grasslands LLC ranches in Montana, biodiversity has increased with conservation grazing. Species once rare or absent are returning.

"In any given year, we leave up to half of the ranch ungrazed, and these pastures are mixed throughout the ranch, so we have a mosaic of ungrazed and grazed patches," Howell said. "And, all of the grazed patches are in different stages of recovery, with different vegetation structures. We effectively create a diverse landscape spread throughout the ranch, conducive to attract a diversity of wildlife."

Since he came to the Padlock, Wayne Fahsholz has been able to increase stocking rates, give less supplemental feed, and work with a smaller crew of cowboys. In addition, he said, the U.S. Fish and Wildlife Service tells him the ranch has created some ideal sage grouse habitat. "The overall range is better," Fahsholz said, "but you really see it in the riparian areas. They aren't all tromped out like they were." And the Padlock Ranch has been sweeping up conservation awards. The ranch won the 2013 Leopold Conservation Award and the 2012-13 Montana Environmental Stewardship Award and was nominated for the National Cattlemen's Beef Association's Environmental Stewardship Award.

Chris Pague, a senior conservation ecologist for The Nature Conservancy based in Colorado, sees a trend to more and more ranchers applying new science to improve rangeland management in ways that both boost vegetation productivity and benefit many wildlife species. The next step is to jump from measuring not just rangeland quality—that is how nutritious and productive is the vegetation—but to measuring the value of those rangelands for wildlife and biodiversity.

Achieving such measurements will require a new kind of thinking and widespread coordination that hasn't happened to date for biodiversity on private and public rangelands in the West.

Economics of Engineering with Livestock:

Incentives for Establishing Biological Diversity

Recognizing the importance of agricultural lands for wildlife, a number of programs in the western United States encourage ranchers to manage rangelands in ways that benefit both landowners and wildlife. Financial incentive for improving biodiversity per se is yet to come.

FEDERAL PROGRAMS

The **Environmental Quality Incentives Program** and **Wildlife Habitat Incentives Program**, administered by the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS), funds and provides technical support for voluntary rangeland enhancements on private lands. An interested landowner can work with NRCS staff to purchase and install water tanks or fences, for example, to control livestock movements. The NRCS requires that individuals who participate in their programs follow conservation guidelines, including livestock stocking rates that are meant to leave enough forage and habitat after livestock graze for wildlife.

These programs target rangeland productivity rather than biodiversity as an outcome. Metrics of success include how many inches high vegetation is after grazing.

"In Wyoming, the only species we are writing grazing systems for and paying enhancements for would be sage grouse," said Rick Peterson, state rangeland management specialist for the NRCS in Wyoming. The new west-wide **Sage Grouse Initiative** pays ranchers for practices that enhance sage grouse habitat on their lands. In two years, the Sage Grouse Initiative has worked with more than 700 ranches, put new grazing systems into practice on more than 2 million acres of sage grouse habitat, marked 500 miles of fence, secured 240,000 acres of conservation easements, and invested over $200 million. Another NRCS program, **Working Lands for Wildlife**, established about one year ago, is funded to the tune of $33 million. Two of the seven species it targets—the lesser prairie chicken and the greater sage grouse—live on western rangelands.

STATE PROGRAMS

While they typically have fewer dollars to leverage than the federal programs, state wildlife agencies work with both public and private landowners to improve habitat on rangelands. The **Wyoming Game and Fish Department Habitat Program** helps coordinate conservation easements of high value to wildlife. In

addition, Game and Fish provides technical assistance to rangeland managers. In 2012, the agency developed nine grazing management plans to boost wildlife habitat on 68,525 acres in Wyoming.

One innovative system for protecting wildlife habitat on private lands is **Colorado Parks and Wildlife's Ranching for Wildlife** program. On properties of 12,000 or more contiguous acres, ranchers implement wildlife habitat improvements, including grazing management to promote big game habitat and conservation plans for threatened and endangered species. They are also required to provide free access and information to public hunters (Colorado residents only) who apply to draw for coveted Ranching For Wildlife licenses. In exchange, ranches receive vouchers for a predetermined number of *private* hunting licenses, which can be distributed to any hunter. To date, over 1.2 million acres on 29 ranches are enrolled, with improved livestock grazing systems on more than 80% of those lands.

NONPROFIT ORGANIZATIONS

Land trusts can also incentivize ranchers by purchasing the development rights for lands rich in wildlife habitat value. The rancher receives a payment equivalent to the difference in market value of the land with and without the easement, as well as a tax deduction for the changed value of the property. Some conservation easement agreements specify grazing management activities to protect or enhance wildlife habitat.

The **Partnership of Rangeland Trusts**, an association of seven statewide agricultural land trusts in the west, has placed nearly 2 million acres into conservation easements. While many of these easements have no specific requirements for habitat protection or enhancements, keeping open ranch lands from being subdivided and developed has value for wildlife.

The Nature Conservancy has developed landscape habitat models to identify private lands with the highest wildlife value in need of conservation. The organization creates conservation easements with stipulations for habitat management that can include grazing programs, essentially paying ranchers to engineer rangelands for biodiversity.

AWARDS AND RECOGNITIONS

Land stewardship awards reward ranchers for grazing their livestock in ways to help wildlife. The Bureau of Land Management gives out a **Rangeland Stewardship Award** to one ranch in the nation each year. In 2012, the award went to the Kirby Creek Coordinated Resource Management Group in Wyoming's Bighorn Basin in recognition of their extensive efforts to restore a degraded watershed through fencing, invasive species control, water developments, and other efforts shared by several ranches and agencies. This prestigious national award comes with public recognition celebrating the management practices of the ranch.

The **Leopold Conservation Award**, distributed by the Sand County Foundation and partnering organizations in eight different states, recognizes land owners who achieve conservation measures on their lands. The Padlock Ranch on the Wyoming/Montana border was recognized in 2013 for innovative grazing management that fosters wildlife habitat, among other practices. The award comes with publicity, recognition from the Governor, and a prize of $10,000.

The Wyoming Game and Fish Department also celebrates landowners who steward wildlife on their properties. One 2012 **Landowner of the Year**, the JY Ranch near Laramie, worked with Wyoming Game and Fish to develop a grazing plan that protects streamside vegetation and produces abundant rangeland forage for wildlife.

MARKET-BASED CONSERVATION FINANCE

While many of the above programs ensure productivity of rangelands and keep them from being developed, they do not measure biodiversity in itself. One upcoming idea to advance biodiversity conservation is tools that give biodiversity economic value in the marketplace. A few forward-thinking organizations are working toward that end, and marketplaces have developed for individual species such as the dunes sagebrush lizard in Texas.

The Environmental Defense Fund develops **habitat exchanges** and other programs to put a monetary value on habitat and species and enable those who benefit from protection of ecosystem services to give financial support to those who protect them. A habitat exchange pays landowners for conservation activities that improve wildlife habitat. Developers purchase credits created by the landowners to offset their impacts to the land.