By Matt Germino

Browsing the Literature

For the August edition of Browsing the Literature, we have 14 papers published in the last few months on 1) monitoring; 2) grazing effects on plants, wildlife, and ecosystem function; and 3) basic ecology of invasive species in rangelands. Note that these lists are nonexhaustive. Feel free to email me suggestions on new papers that are not from *Rangeland Ecology & Management* or *Rangelands*, and I will include them, provided they are sufficiently relevant.

In an upcoming edition, I will be interviewing current or recent graduate students in rangeland ecology to ask which papers we have not yet covered are affecting their research or direction. If you are a student and would like to participate, please email me the citation for one or more papers from 2018 that we have not yet covered in 2018, and one to three sentences on what information each paper contributes to rangeland science and management (i.e., why you picked the paper). Please email any contributions to me at mgermino@usgs.gov.

Here are two interesting recommendations on monitoring from Dr. Jason W. Karl, Rangelands Editor-in-Chief and Associate Professor at University of Idaho

Monitoring butterflies with an unmanned aerial vehicle: current possibilities and future potentials. Ivosevic, B.Y. Han, G., and Kwon, O. 2017. *Journal of Ecology and Environment* 41:12.

The authors of this paper describe a protocol for identifying and counting Libythea celtis butterflies from high-resolution drone imagery. While the direct impact of this paper to rangeland management is modest, the paper is noteworthy because it illustrates the potential of small, inexpensive unmanned aerial vehicles (i.e., drones) to revolutionize how we measure and monitor many different aspects of ecosystems.

Identifying optimal remotely-sensed variables for ecosystem monitoring in Colorado Plateau drylands. Poitras, T.B., Villarreal, M. L., Waller, E. K., Nauman, T. W., Miller, M. E., and Duniway, M. C. 2018. *Journal of Arid Environments* 153:76–87.

Most remote sensing applications in rangeland management (and ecology in general) either rely on default vegetation indices and products without assessing their validity to the study objective or attempt to translate image data into indicators traditionally measured in the field regardless of whether there is a strong statistical relationship to model from. Poitras et al. outline an approach for selecting the best-performing remote-sensing products for monitoring vegetation changes.

Wildlife response to rangeland management

Cattle grazing and fish recovery on US federal lands: can social–ecological systems science help? Charnley, S., Gosnell, H., Wendel, K. L., Rowland, M. M., and Wisdom, M. J. 2018. *Frontiers in Ecology and the Environment* 16(S1).

This paper describes how social-ecological systems science can be incorporated into rangeland management of federal lands to reduce grazing impacts on riparian areas and thereby reduce impacts on threatened and endangered fish. This program is part of the Mountain Social Ecological

Observatory Network's Blue Mountain Working Group, in Oregon. The goal is to find and establish innovative grazing management practices that can reduce the need for top-down regulatory control, and a motivation is that both ranching operations and fish recovery benefit from healthy riparian resources.

Effects of rangeland management on survival of female greater prairie-chickens. Winder, V. L., McNew, L. B., Pitman, J. C., and Sandercock, B. K. 2018. *The Journal of Wildlife Management* 82:113–122.

Rotational patch-burn grazing systems reduced impacts to greater prairie chickens (Tympanuchus cupido) in the Flint Hills of Kansas, in a study comparing ranches using different grazing strategies. The species has declined because of annual prescribed burning and high stocking densities in livestock operations. A rotational patch-burn grazing system, which increases landscape heterogeneity and primary productivity, led to 35% greater survival of female prairie chickens on properties compared with properties that use annual burning and intense early cattle use.

Effects of rotational grazing management on nesting greater sage-grouse. Smith, J. T., Tack, J. D., Berkeley, L. I., Szczypinski, M., and Naugle, D. E. 2018. *The Journal of Wildlife Management* 82:103–112.

Rotational grazing or rest from grazing did not increase nest success for greater sage-grouse in the Northern Great Plains of Montana. The evidence comes from Bayesian analysis of daily survival rates of ~500 nests monitored for 6 years, comparing ranches using different grazing strategies. Herbaceous vegetation height and cover also did not vary among the grazing systems.

Grazing effects on ecosystem carbon

Rotational and continuous grazing does not affect the total net ecosystem exchange of a pasture grazed by cattle but modifies CO_2 exchange dynamics. de la Motte, L. G., Mamadou, O., Beckers, Y., Bodson, B., Heinesch, B., and Aubinet, M. 2018. *Agriculture, Ecosystems & Environment* 253:157–165.

Choice of grazing system can influence biosphere-atmosphere interactions, specifically timing of carbon uptake. In Belgium, net ecosystem exchange of carbon dioxide differed between a site using rotational grazing with periods of rest alternating with high stocking periods and a site using continuous grazing. Not surprisingly, net CO_2 uptake was relatively less after the intensive grazing but during the rest period became greater as biomass recovered compared with the continuous grazing site. Over the course of a year, however, there was no difference in net ecosystem exchange between the two sites.

Grazing enhances belowground carbon allocation, microbial biomass, and soil carbon in a subtropical grassland. Wilson, C. H., Strickland, M. S., Hutchings, J. A., Bianchi, T. S., and Flory, S. L. 2018. *Global Change Biology* 24:2997–3009.

Allocation of carbon to roots and relative contributions of microbial and plant inputs to soil organic carbon were measured in replicate, long-term grazing exclosures and grazed areas in Florida, using a stable-isotope pulse-chase methodology. There was much less belowground allocation and thus soil carbon in the ungrazed areas than in the grazed pasture.

Grazing effects on plant diversity

Effects of grazing intensity on plant richness and diversity: a meta-analysis. Herrero-Jáuregui, C. and Oesterheld, M. 2018. *Oikos* 6:757–766.

This study determined how stocking rates affect species richness and diversity of grasslands under different environments and contexts, globally, using a meta-analysis. Diversity was greatest at moderate stocking rates and the relationship of richness and diversity to grazing did not vary with precipitation, aridity, or productivity, although richness was more negatively related to stocking rate in subhumid and humid environments. The authors conclude that diversity is less affected by stocking rate than the stronger impacts to species composition found in previous research.

Long-term grazing impacts on vegetation diversity, composition, and exotic species presence across an aridity gradient in northern temperate grasslands. Lyseng, M. P., Bork, E. W., Hewins, D. B., Alexander, M. J., Carlyle, C. N., Chang, S. X., and Williams, W. D. 2018. *Plant Ecology* 219:649–663.

The response of plant diversity and richness to long-term livestock grazing was evaluated across 107 northern temperate grasslands differing in aridity, in Alberta, Canada. Grazing modestly increased total species richness and in mesic conditions increased grasses relative to shrubs, but did not affect diversity. Exotic plant diversity was more responsive to the interaction of grazing and aridity, with more exotics prevailing with grazing in mesic conditions. Overall, however, the authors suggest semiarid northern temperate grasslands are relatively resistant to grazing, including invasion by woody or exotic species.

Comparing the impact of a grazing regime with European bison versus one with free-ranging cattle on coastal dune vegetation in the Netherlands. Valdés-Correcher, E., Rodriguez, E., Kemp, Y. J., Wassen, M. J., and Cromsigt, J. P. 2018. *Mammal Research* 18:1–12.

Woody plant encroachment into grazing pastures is common globally, and often considered undesirable. In the dunes of Zuid-Kemmerland National Park of Netherlands, European bison, horses, and cattle were introduced to reverse the encroachment of grass and shrub species. These authors compared 8 years of woody and grassy vegetation data on fixed transects in an area with European bison and horses, another area with cattle and horses, and a third area where these large grazers were excluded, although all sites had rabbit and deer. Woody species decreased at all sites during the study, along with grass height and herbs, but species-specific impacts were evident with certain ungulates impacting different woody species.

Introduced and native herbivores have different effects on plant composition in low productivity ecosystems. Travers, S. K., Eldridge, D. J., Dorrough, J., Val, J., and Oliver, I. 2018. *Applied Vegetation Science* 21:45–54.

In Southeast Australia, these authors asked how vegetation responses to recent vs. long-term livestock, rabbit, and kangaroo grazing differ, and measured fecal pellets and primary productivity from satellites. Native species, particularly forbs and geophytes, were reduced with recent and historic livestock and rabbit grazing. Few impacts of kangaroo grazing were evident.

Basic ecology of invasive species in rangelands

Climate-driven diversity change in annual grasslands: Drought plus deluge does not equal normal. Harrison, S. P., LaForgia, M. L., and Latimer, A. M. 2018. *Global Change Biology* 24:1782–1792.

The response of plant species richness to the recent drought cycle (drought followed by the wet 2016–2017 winter) in California was evaluated under ambient and experimentally watered conditions in 80, 5-m^2 plots that had been read over 18 years. During the 18 years, the relationship of winter rainfall to species richness weakened, and species richness did not recover from drought after the wet post-drought winter. In experiments on 100, 1-m^2 plots, native annual forbs increased with winter irrigation.

Niche opportunities for invasive annual plants in dryland ecosystems are controlled by disturbance, trophic interactions, and rainfall. Gill, R. A., O'Connor, R. C., Rhodes, A., Bishop, T. B., Laughlin, D. C., and Clair, S. B. S. 2018. *Oecologia* 187:1–11.

These authors tested the effects of moisture availability and rodent density on invasive species after fires in the Mojave and Great Basin deserts, using a nested fully factorial experiment. Invasives were initially controlled by disturbance and trophic interactions but then more influenced by resource availability and competition. In the Great Basin, fire initially increased the exotic forb Halogeton glomeratus, but 4 years later the invasive annual grass Bromus tectorum suppressed Halogeton glomeratus in rodent exclusion plots. In the Mojave Desert, rodents increased the invasive grass Schismus arabicus and negatively affected Bromus rubens, but Bromus rubens increased with fall rain events.

Seed banks of native forbs, but not exotic grasses, increase during extreme drought. LaForgia, M. L., Spasojevic, M. J., Case, E. J., Latimer, A. M., and Harrison, S. P. 2018. *Ecology* 99:896–903.

Annual forbs, especially early season species, are often not well accounted or managed for in rangelands. During the unusual drought experienced in California, from 2012 to 2015, seeds of exotic annual grasses decreased and seeds of native annual forbs increased. Within native annual forbs, species with low specific leaf area (small leaf area per unit leaf weight, a climate stress adaptation) increased. The findings were generated from germinating seeds from soil cores collected early and later in the drought and identifying the 22,000 plants that culminated from the effort.

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