Browsing the Literature

For the June 2022 issue of Browsing the Literature, we have a few features from Rangeland Ecology & Management and other journals. This edition has a relatively heavy focus on the timely issues of livestock grazing, exotic annual grass invasions, and their interactions.

-Matt Germino
May 2, 2022

Rangeland Ecology & Management highlights: Grazing and annual grasses

Identifying structural thresholds in annual grass–invaded rangelands
Wood CW, Mealor BA. 2022. *Rangeland Ecology & Management,* 83:1-9 https://doi.org/10.1016/j.rama.2022.02.010

Thresholds of vegetation response to treatments are needed to guide management plans and actions. Across a gradient of the relative abundances of exotic annual cheatgrass and perennial grasses in rangelands of Wyoming, perennial grass biomass increased where cheatgrass:perennial cover was 4:1 but not where the ratio was 10:1.

Management strategies determine how invasive plant impacts on rangeland provisioning services change net revenue on California annual rangeland
James JJ, Brownsey P, Davy J, Forero L, Stackhouse J, Shapero M, Becchetti T, Rinella M. 2022. *Rangeland Ecology & Management*, 82:29-36. https://doi.org/10.1016/j.rama.2022.02.001

Knowing the true ecological and economic impacts of exotic invaders is key for justifying management actions targeting exotic annuals. Exotic annual grasses are generally assumed to lower forage quantity and quality and thus negatively affect livestock operations. In California rangelands, support of livestock density was less in rangelands with more exotic annual grass medusahead, but revenue impacts depended on management. Shortening grazing season in response to medusahead led to reductions in revenue but reducing livestock density and selling led to increased revenue.

Moderate grazing during the off-season (Fall-Winter) reduces exotic annual grasses in sagebrush-bunchgrass steppe
Davies, K.W., Boyd, C.S., Copeland, S.M., Bates, J.D. 2022. *Rangeland Ecology & Management,* 82: 51–57. https://doi.org/10.1016/j.rama.2022.02.003

Livestock grazing is a passive restoration tool which can be applied across vast areas of sagebrush rangelands to potentially manage exotic annual grasses. Areas moderately grazed (40-60% utilization) during fall and winter for 6-10 years had less exotic annual grass cover and greater Sandberg's bluegrass (*Poa secunda*) density than ungrazed areas. Furthermore, high bunchgrass density and biological soil crust cover was similar between grazed and control areas. These findings suggest, if properly managed, livestock grazing may indirectly increase resistance to exotic annual grasses by increasing Sandberg's bluegrass density in sagebrush rangelands where exotic annual grass cover is relatively low (<10%).
Contributor: Dr. Christopher "Digger" Anthony

Grazing effects on shrub-induced resource islands and herbaceous vegetation heterogeneity in sagebrush-steppe communities
Davies, K.W., Boyd, C.S., Copeland, S.M., Bates, J.D. 2022. *Global Ecology and Conservation,* 35: e02106. https://doi.org/10.1016/j.gecco.2022.e02106

The effects of livestock grazing on the spatial structure of sagebrush communities is largely unknown. In areas with relatively low exotic annual grass cover (2-6%) and moderate perennial grass cover (10-18%), moderate grazing (30-50% use of available

forage) over +80 years had limited effects on the spatial heterogeneity of soil nutrients, herbaceous vegetation, and ground cover. Grazing reduced the cover of perennial grasses and forbs and biological soil crusts in the interspaces of vegetation relative to underneath vegetation, but the density of perennial and exotic annual grasses was similar.
Contributor: Dr. Christopher "Digger" Anthony

Regular contributions

Livestock use on public lands in the Western USA exacerbates climate change: Implications for climate change mitigation and adaption
Kauffman, J.B., Beschta, R.L., Lacy, P.M., and Liverman, M. 2022. *Environmental Management*
https://doi.org/10.1007/s00267-022-01633-8

Domestic livestock grazing on public lands in the western U.S. can have a profound influence on future climates. These authors provide a review of the direct and indirect impacts of livestock grazing on climate change (see Fig. 1 reproduced from the article) and a quantitative summary relating livestock grazing to carbon storage and greenhouse gasses.
*Contributor: Dr. Christopher "*Digger*" Anthony:*

Organic and inorganic soil carbon in a semi-arid rangeland is primarily related to abiotic factors and not livestock grazing
McKenna MD, Grams SE, Barasha M, Antoninka AJ, Johnson NC. 2022. *Geoderma*, 115844.
https://doi.org/10.1016/j.geoderma.2022.115844

The partitioning of carbon into organic and non-organic forms is critical for understanding carbon sequestration in rangelands. In Northern Arizona, USA, these carbon forms did not vary among shallow-soil samples at 60 locations along grazed and ungrazed sides of fences. Instead, substantial variation resulted from bedrock substrate and long-term precipitation differences among the sampling locations.
Contributor: Matt Germino

Monitoring standing herbaceous biomass and thresholds in semiarid rangelands from harmonized Landsat 8 and Sentinel-2 imagery to support within-season adaptive management
Kearney SP, Porensky LM, Augustine DJ, Gaffney R, Derner JD. 2022. *Remote Sensing of Environment,* 271:112907. https://doi.org/10.1016/j.rse.2022.112907

Tuning the timing of livestock grazing is one of the greatest prospects for enhancing the sustainability of grazing and is needed to guide targeted grazing decisions. New remote sensing platforms are increasing the frequency and quality of information needed to assess the large pasture areas for which rapid decisions on livestock must be made, but how reliable are these? Models using the latest Landsat and Sentinel-2 data parameterized or tested with high-resolution plant community maps and herbaceous biomass data from 1764 ground observations collected over 8 years in North American shortgrass steppe provided up to 87% accuracy when biomass decreased below thresholds as low as 450 kg ha^{-1}.
Contributor: Matt Germino

Importance of timing: Vulnerability of semi-arid rangeland systems to increased variability in temporal distribution of rainfall events as predicted by future climate change
Fust, P. and Schlecht, E., 2022. *Ecological Modelling,* 468: p.109961. https://doi.org/10.1016/j.ecolmodel.2022.109961

Models forecast drier conditions for many semi-arid rangelands, but changes in the variability in precipitation may be even more important. A forage production module was developed for a spatially explicit, agent-based model of livestock movement in semi-arid rangelands (RaMDry) and applied to sub-tropical, semi-arid rangelands. Changes in the timing of precipitation events and specifically dry periods led to major reductions in quantity and quality of forage and livestock body weights.
Contributor: Matt Germino

A meta-analysis of the effects of habitat aridity, evolutionary history of grazing and grazing intensity on bee and butterfly communities worldwide
Thapa-Magar KB, Davis TS, Fernández-Giménez ME. 2022. *Ecological Solutions and Evidence*, e12141. https://doi.org/10.1002/2688-8319.12141

Over 59 studies globally, pollinator abundance and richness were negatively related to high grazing intensities in humid but not semiarid rangelands. Within semi-arid habitats, pollinator richness was less with grazing in with short evolutionary histories of grazing. Negative impacts were greater on species richness of social bees and butterflies but not solitary bees
Contributor: Matt Germino

How do accuracy and model agreement vary with versioning, scale, and landscape heterogeneity for satellite-derived maps in sagebrush steppe?
Applestein CA, Germino MJ. 2022. *Ecological Indicators*, https://doi.org/10.1016/j.ecolind.2022.108935

Maps of the distribution and abundance of dominant plants derived from satellite data are increasingly available for ecological research and management, but there are relatively few quantitative assessments of the accuracy of the resulting vegetation maps, nor is there guidance on how the accuracy varies with scale of application. A key question is "how small of an area can the data be relied upon to accurately represent vegetation?". The three dominant vegetation models used in USA rangelands, specifically the Rangeland Assessment Platform (RAP), the Rangeland Condition Monitoring and Assessment Platform (RCMAP), and US Geological Survey Fractional Cover estimates were compared against one of the most robust field assessments of vegetation cover available, specifically >1000 plots across >100 kHa on the 2015 Soda Wildfire area. The analyses reveal a central problem in answering the question, which is that a model must be made to scale up field data to the level of groups of pixels that are comparable to satellite data. Model agreement improved with

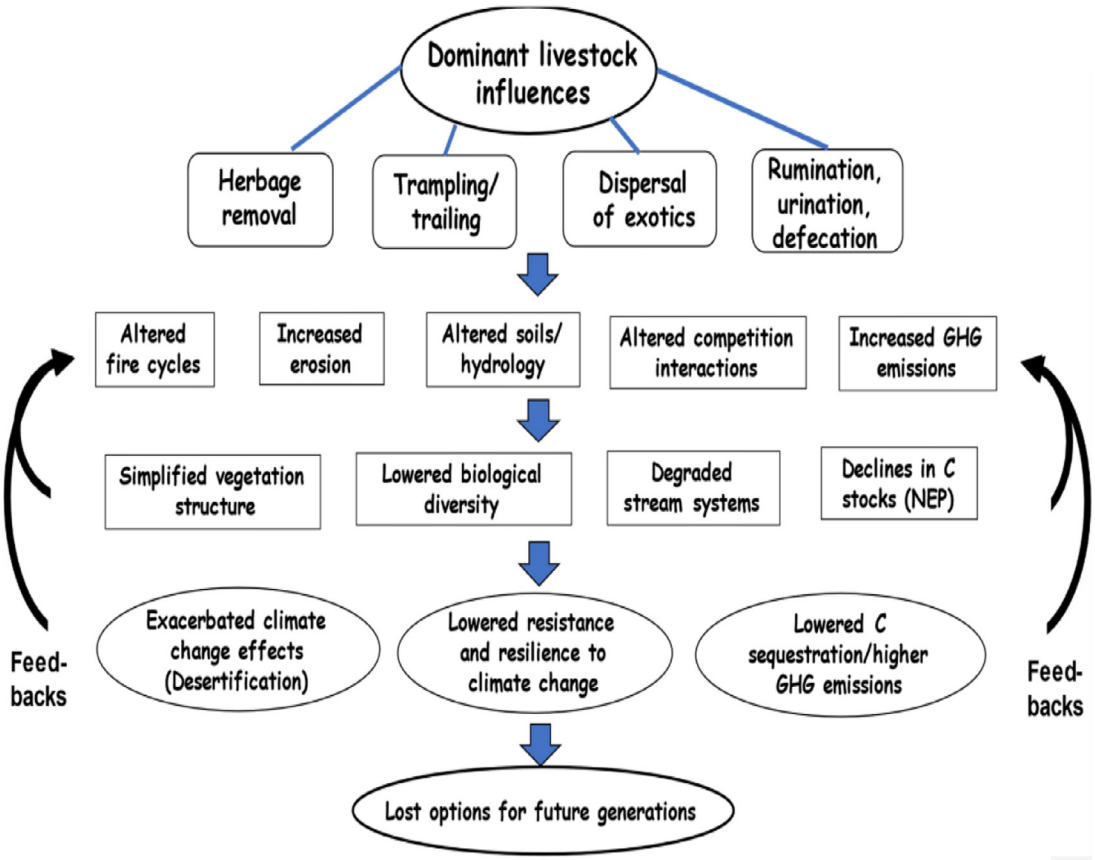

Fig. 1. The interacting effects of livestock grazing and climate change on western rangelands. There are four primary immediate effects of livestock: herbage removal, trailing trampling effects, dispersal of exotics, and creation of metabolic and nonmetabolic waste products. Through time, these effects on native rangelands affect fire regimes, increase erosion, compact soils affecting ecosystem hydrology, and alter competitive relationships between plant species. These actions decrease the net ecosystem productivity (NEP) such that rangelands shift from carbon sinks to net sources of greenhouse gases. Products of animal metabolism are significant additional sources of greenhouse gases, especially CH_4 and N_2O. Ultimately the results of grazing have led to a simplification of vegetation structure typified by increases in exotic, ruderal, and less palatable species that are more adapted to drier conditions created by lower water holding capacities of compacted soils. The shifts in species composition further decrease the capacity of rangeland ecosystems to function as carbon sinks. Other impacts of grazing include a decline in riparian vegetation structure, shifts to drier species dominance, and degraded stream channels which increase stream temperatures, ground surface temperatures, and alter stream flows. The consequent shifts in the net ecosystem productivity of the landscape, coupled with GHG additions from livestock, results in additional contributions to the greenhouse gases causing climate change. The effects of livestock accentuate the effects of climate change such as increased stream and air temperatures, loss in biological diversity, and an overall decline in the productivity of rangelands (desertification). There are also strong feedbacks associated with climate change. The warmer and drier temperatures, and reduced snowpack associated with climate change interacts with livestock grazing to negatively affect stream flows, water quality, and biological diversity. These factors result in further degradation and a lower capacity for carbon storage, hence higher greenhouse gas emissions. Reproduced from Kauffman et al. 2022 (Creative Commons Attribution 4.0 International License).

coarser scale of application, but errors in estimates were high for many platform and vegetation targets. Accuracy could be predicted from background landscape variables, such as elevation.
Contributor: Matt Germino

Invasive annual cheatgrass enhances the abundance of native microbial and microinvertebrate eukaryotes but reduces invasive earthworms
Porazinska, D.L., Seastedt, T.R., Gendron, E. and Schmidt, S.K. 2022. *Plant and Soil*, pp.1-14. https://doi.org/10.1007/s11104-022-05312-9

Cheatgrass dominated plant communities had lower invasive earthworm populations compared to perennial grass stands in the Western Great Plains region of Colorado. As a result, increased soil organic matter is found under cheatgrass stands compared to what might be expected. It is hypothesized that dryer soils under cheatgrass stands create an undesirable environment for the earthworms, which decreases soil organic matter decomposition. The study suggests fostering plant communities that draw down surface soil moisture by early summer may help to control invasive invertebrate populations and their undesirable impacts on soil carbon storage.
Contributor: Dr. Toby Maxwell