By Matt Germino

Browsing the Literature

For this edition of *Browsing the Literature*, I uncovered the most recent papers using "rangeland," "grazing," and "semiarid" search terms in Google Scholar and by viewing the new article content on several relevant journals. An array of articles from around the world was revealed on the topics of grazing and climate effects, plant community interactions, wildlife responses, and hydrological and soil functioning.

Please forward the citations to me for the most recent papers by you, your colleagues, or any other new rangeland papers that have a DOI number and are available online but have not yet been covered in this column, and are either in press or very recently published. Contact Matt Germino at mgermino@usgs.gov.

Papers of Global Scope

Cross-boundary human impacts compromise the Serengeti-Mara ecosystem. Veldhuis, M.P., Ritchie, M.E., Ogutu, J.O., Morrison, T.A., Beale, C.M., Estes, A.B., Mwakilema, W., Ojwang, G.O., Parr, C.L., Probert, J., and Wargute, P.W. 2019. *Science* 363(6434):1424–1428.

A synthesis of data sources over 40 years revealed that intensified human impacts along the boarders of the vast Serengeti-Mara protected area caused native grazers to be centrally concentrated within the protected area. The greater grazing impacts included reduced productivity, wildfire fuels, and soil fertility, including carbon uptake. Reducing human degradation of habitat outside the protected areas could thus increase the quality and effectiveness of the protected habitat.

Overcompensation: a 30-year perspective. Ramula, S., Paige, K.N., Lennartsson, T., and Tuomi, J. In Press 2019. *Ecology*.

This article is the conceptual introductory article for a 6-paper special feature on overcompensation theory in the journal *Ecology*, which can be an important consideration in predicting or understanding the impacts of grazing by native or domestic grazers. The articles address the costs to plants of replacing lost tissue and the "Optimal Defense Theory" in which plant allocation to herbivory defense increases or timing of growth is altered as adaptive responses to grazing.

Livestock herbivory shapes fire regimes and vegetation structure across the global tropics. Bernardi, R.E., Staal, A., Xu, C., Scheffer, M., and Holmgren, M. In Press 2019. *Ecosystems*.

Variation in vegetation height and cover, inferred from remote sensing, was compared among areas differing in livestock density, climate, and fire in low-latitude areas. Areas with more livestock had less fire and more shrubs and small trees, and this was particularly evident in the high stocking rates and low fire occurrence of South America compared with Africa and Australasia. The results pertain to areas receiving 100 to 150 cm of precipitation per year.

From the United Kingdom

Grazing exclusion and vegetation change in an upland grassland with patches of tall herbs. S.H. Watts, S.H., Griffith, A., and Mackinlay, L. In Press 2019. *Applied Vegetation Science*.

In relatively wet rangelands of Scotland, grazing exclusion allowed ecologically important but grazing-intolerant forbs to expand from their refugia among inaccessible rock outcrops over a nearly 20-year period. Grazing-tolerant grasses and low-statured annual herbs also decreased in relative abundance, and the plant community now appears structured more by competition for light rather than resilience to herbivory.

From Austral Regions

Biotic and abiotic drivers of topsoil organic carbon concentration in drylands have similar effects at regional and global scales. Gaitán, J.J., Maestre, F.T., Bran, D.E., Buono, G.G., Dougill, A.J., Martínez, G.G., Ferrante, D., Guuroh, R.T., Linstädter, A., Massara, V., and Thomas, A.D. In Press 2019. *Ecosystems*.

In a synthesis across 185 sites in Patagonia and 31 sites elsewhere around the world, the organic carbon content (SOC) of semiarid soils were equally affected by variation in primary productivity and the abiotic factors of rainfall, temperature, and soil texture. SOC was positively related to plant productivity and precipitation and negatively related to maximum temperatures and sand content.

Limited evidence of compositional convergence of restored vegetation with reference states after 20 years of livestock exclusion. Sims, R.J., Lyons, M., and Keith, D.A. In Press 2019. *Austral Ecology*.

A conceptual model of grazing-exclusion fencing effects was developed for Southeast Australia based on a nearly 20-year chronosequence of timing of different fenced-area establishments. Invasive species were common after establishing the fencing, and there was little recovery to reference conditions.

From China

Different effects of spring and summer droughts on ecosystem carbon and water exchanges in a semiarid shrubland ecosystem in Northwest China. Liu, P., Zha, T., Jia, X., Black, T.A., Jassal, R.S., Ma, J., Bai, Y., and Wu, Y. In Press 2019. Ecosystems.

In *Artemisia ordosica* rangelands of Northwest China, severe spring drought suppressed gross ecosystem productivity as indicated by CO_2 uptake, in addition to ecosystem respiration and evapotranspiration, much more than summer droughts, according to eddy covariance measurements. Seasonal timing of drought is perhaps as or more important than annual precipitation deficit.

From Canada

Biotic homogenization within and across eight widely distributed grasslands following invasion by *Bromus inermis*. Stotz, G.C., Gianoli, E., and Cahill, Jr., J.F. In Press 2019. *Ecology*.

Smooth brome (*Bromus inermis* L) has been widely introduced across many rangelands and reclamation sites across Western North America and has frequently become a strong dominant of the sites and invaded neighboring sites. Like the many other grass invasions occurring worldwide, a key impact is homogenization of plant community structure. In eight grasslands of Alberta, sharp shifts in relative abundance of species was a principle cause of homogenization, which were associated with reduced sunlight and increased nutrient availability, which are proposed to reinforce smooth brome's dominance.

From the United States

Wind erosion and dust from US drylands: a review of causes, consequences, and solutions in a changing world. Duniway, M.C., Pfennigwerth, A.A., Fick, S.E., Nauman, T.W., Belnap, J., and Barger, N.N. 2019. *Ecosphere* 10:e02650.

Wind erosion is a major issue for rangelands, and over half of the >150 million acres in the United States that are mapped as highly erodible are on federal public lands. The literature suggests that soils in these relatively dry areas that are used primarily for livestock tend to be relatively stable until disturbances such as fire render them vulnerable to wind erosion. The resulting dust can have geographically extensive impacts, such as darkening distant snowfields and accelerating snowmelt, or locally deleterious impacts on restoration efforts.

Vegetation and precipitation shifts interact to alter organic and inorganic carbon storage in cold desert soils. Huber, D.P., Lohse, K.A., Commendador, A., Joy, S., Aho, K., Finney, B., and Germino, M.J. 2019. *Ecosphere* 10:e02655

In one of the longest-running dryland ecohydrology experiments globally, sagebrush-steppe became less apt to store soil carbon with increased winter precipitation via nearly 20 years of irrigation. Whether communities were composed of native perennials or the exotic crested wheatgrass strongly affected the patterns of carbon sequestration. Soil inorganic carbon evaluated across shallow and deeper (1 meter) depths were critical for accurate representation of the soil carbon changes.

Hydrologic function of rapidly induced biocrusts. Fick, S.E., Barger, N., and Duniway, M. 2019. *Ecohydrology*. https://doi.org/10.1002/eco.2089.

The hydrological function of biological crusts grown with or without organic soil stabilizer were tested on degraded grass rangelands of the Colorado Plateau, United States. Biocrusts reduced infiltration except when the stabilizer was added. Biocrusts improved infiltration at lower rainfall levels. The effects appeared to shift as the structure of the biocrusts evolved over time.

The combined effects of an extreme heatwave and wildfire on tallgrass prairie vegetation. Ratajczak, Z., Churchill, A.C., Ladwig, L.M., Taylor, J.H., and Collins, S.L. In Press 2019. *Journal of Vegetation Science*.

At the Konza Prairie Biological Station, heatwave led to no or only small changes in structure, diversity, and composition of tallgrass prairie. However, the combination of heatwave and previous fire led to 80% less grass cover, 50% greater forb cover, and greater plant diversity for at least 2 years after fire.

Quantifying ecological integrity of terrestrial systems to inform management of multiple-use public lands in the United States. Carter, S.K., Fleishman, E., Leinwand, I.F., Curtis, H., Flather, C.H., Carr, N.B., Fogarty, F.A., Leu, M., Noon, B.R., Wohlfeil, M.E., and Wood, D.J.A. In Press 2019. *Environmental Management*.

Six attributes of ecosystem structure, function, and composition related to resources and stressors emerged as the most useful indicators for ecological integrity in Nevada's shrub rangelands. Plant invasion and disturbance were highest in the northwest and southwest areas of the state, and departure of the plant community from normal landscape configurations was greatest in the central and northern areas.

Threshold responses of grassland and sagebrush birds to patterns of disturbance created by an ecosystem engineer. Duchardt, C.J., Augustine, D.J., and Beck, J.L. In Press 2019. *Landscape Ecology*.

Bioturbation of soils by burrowing mammals is common in many rangelands and may affect ecosystem functioning. In the Northern Great Plains, birds such as Brewer's sparrow and sage thrasher, which require sagebrush habitat, were much less abundant where shrublands had prairie dog disturbance. In contrast, mountain plovers, which specialize on shortgrass steppe, were most abundant along prairie dog colonies.

Landscape and organismal factors affecting sagebrush-seedling transplant survival after megafire restoration. Davidson, B.E., Germino, M.J., Richardson, B., and Barnard, D. In Press 2019. *Restoration Ecology*.

Restoring dominant perennials in rangelands impacted by fire and threatened by invasion of annual grass can be improved with a better understanding of the factors causing variability in their establishment. Survival and growth were measured on 3,000 nursery-reared sagebrush seedlings transplanted by rangeland managers along with ~1,000,000 other seedlings across many thousands of acres on the 285,000 acres burned in the 2015 Soda Fire in Oregon and Idaho. Differences in survival were related most to spatial variation in soil mapping units that had buried restrictive layers and to cover of annual grasses, steepness, and burn severity.

Competition suppresses shrubs during early, but not late, stages of arid grassland-shrubland state transition. Pierce, N.A., Archer, S.R., and Bestelmeyer, B.T. In Press 2019. *Functional Ecology*.

In mesquite rangelands of the Southwest United States, relative abundances of grasses and shrubs were experimentally manipulated with foliar herbicide to test competitive interactions. Small shrubs increased in wet years where grasses around them had been removed, an effect not observed for large shrubs in dry years. Whereas neighborhood metrics suggested competition among shrubs was generally occurring, the experimental outcomes suggested this was not the case.

Native seeds incorporated into activated carbon pods applied concurrently with indaziflam: a new strategy for restoring annual-invaded communities? Clenet, D.R., Davies, K.W., Johnson, D.D., and Kerby, J. In Press 2019. *Restoration Ecology*.

Restoration of native perennials in rangelands affected by exotic annual grasses requires the potentially antagonistic treatments of seeding natives while also applying pre-emergent herbicides. Sagebrush and bunchgrasses established better from seed when the pre-emergent herbicide indaziflam was incorporated into a seed pod containing activated carbon.

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