



By Matt Germino

Browsing the Literature

For this edition of Browsing the Literature, I feature a recent special issue in the journal *Science* highlighting challenges and opportunities for the earth's grassland ecosystems. The premise is that grasslands are neglected compared to higher-value ecosystems such as forests, but grasslands are vital to humans and for adapting to climate change. Additionally, I included recent and forthcoming articles on rangeland ecology and management in the *Journal of Applied Ecology* as well as two highlights from *Rangeland Ecology & Management*.

From *Rangeland Ecology & Management*

Rancher experiences and perceptions of climate change in the Western United States.

Saliman, A. and Petersen-Rockney, M., 2022. *Rangeland Ecology & Management*, 84, pp.75-85. <https://doi.org/10.1016/j.rama.2022.06.001>

A qualitative review of published surveys about how ranchers think about and act on climate change is used to support these authors' opinions on how climate change programs might best engage ranchers. Management flexibility and diversification of income sources are key avenues for ranch adaptation to weather variability, especially drought. Reactive adaptation to drought includes in order of decreasing importance: destocking, purchasing hay reserves, adding non-agricultural income, and applying for government assistance. Proactive responses are less prevalent and include rest or rotational grazing, water or irrigation improvements, monitoring, and increasing rangeland health.

Moving toward the greener side: Environmental aspects guiding pastoral mobility and impacting vegetation in the Dzungarian Gobi, Mongolia.

Michler, L.M., Kaczensky, P., Ploechl, J.F., Batsukh, D., Baumgartner, S.A., Battogtokh, B., and Treydte, A.C., 2022. *Rangeland Ecology & Management*, 83, pp.149-160. <https://doi.org/10.1016/j.rama.2022.03.006>

In the Dzungarian area of the Gobi Desert of Mongolia, GPS tracking of 19 goat herds over nearly 2 years revealed the factors affecting herd camp locations and localized grazing impacts. Herders changed camp locations a mean of 9 times/year, staying 25-49 days/camp and moving 70-123 km between camps. Livestock spent most of their time within 100 m of camps. Biomass availability was a key predictor of movement of camp locations, especially for *Stipa* grass communities, but shelter from wind was a stronger factor in winter. There was little evidence of gradients in plant diversity around camp locations. Herd mobility is a key aspect of adaptation for this grazing system.

Special issue in Science: The unrecognized value of grass

Grassland soil carbon sequestration: Current understanding, challenges, and solutions.

Bai, Y. and Cotrufo, M.F., 2022. *Science*, 377(6606), pp.603-608. <https://doi.org/10.1126/science.abo2380>

This review of carbon in grasslands emphasizes that a third of terrestrial carbon is in grasslands, and factors such as grassland plant diversity can increase sequestration of soil carbon, but climate change can impact both carbon uptake by plants and release by microbes. The authors argue that carbon sequestration in terms of CO₂ equivalents/year could be increased by

2.3-7.3 billion tons by biodiversity restoration and 148-699 megatons by improved grazing management.

Ancient grasslands guide ambitious goals in grassland restoration.

Buisson, E., Archibald, S., Fidelis, A., and Suding, K.N., 2022. *Science*, 377(6606), pp. 594-598. <https://doi.org/10.1126/science.abo4605>

When, where, and why we can or cannot restore grasslands is an important question for the billion or so people who depend on them across 40% of the earth's land surface. But attention to the issue has trailed restoration of other habitats, such as forests. Most grasslands are easily and quickly degraded, and their biological structure and function can be exceedingly difficult to recover. In this paper, the authors suggest that recognition of the long time periods required for ecosystem recovery and the strong feedbacks and thresholds resisting recovery are challenging yet critical considerations for grassland restoration. The authors emphasize a concept of 'old-growth' grasslands.

Experiments reveal benefits and impacts of grazing

Nonlinear response of the soil seed bank and its role in plant community regeneration with increased grazing disturbance

An, H., Baskin, C.C., Ma, M., 2022. *Journal of Applied Ecology*. In Press. <https://doi.org/10.1111/1365-2664.14259>

A field study in Tibetan wet-alpine meadows (see photos reproduced from article; CC BY-NC 4 license) reveals plant-community regeneration after high grazing intensity is more

dependent on persistent than transient seed banks. This is especially the case when the species' diversity of the seed-bank pool is greater than a threshold level identified by these authors. Data suggest loss of species diversity can lead to undesirable plant-community state transitions via loss of the persistent seed bank pool.



Fallow deer foraging alone does not preserve the vegetation of traditionally sheep-grazed calcareous grasslands

Rupprecht, D., Jedrzejek, B., Holzel, N. 2022. *Journal of Applied Ecology*. In Press. <https://doi.org/10.1111/1365-2664.14253>

A decade-long fencing experiment in calcareous grasslands of northwest Germany excluded either herded sheep, wild deer, or both. Exclusion of sheep reduced species diversity, litter accumulation, and shrub encroachment. Increases in litter and shrubs led to loss of short-statured (e.g., rosette-forming) or annual species (see photo below, reproduced from article; CC BY-NC 4 license). Use by deer only marginally reduced litter and shrub encroachment, even though deer are abundant and known to impact vegetation in this region.



From Rupprecht et al. 2022

Forage provision is more affected by droughts in arid and semi-arid than in mesic rangelands

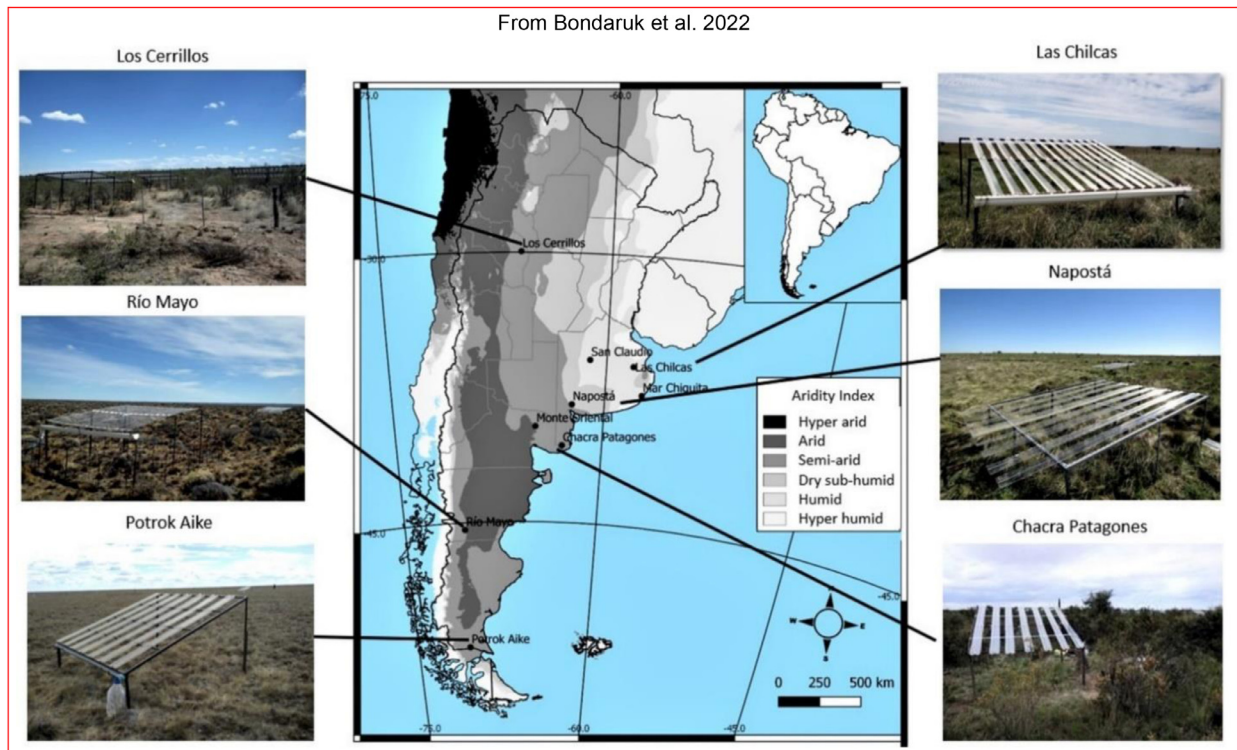
Bondaruk, V.F., Onatibia, G.R., Frenandez, R.O. et al. 2022. *Journal of Applied Ecology*. <https://doi.org/10.1111/1365-2664.14243>

Sensitivity to drought of nine rangelands spanning an aridity gradient in Argentina using rain-out shelters to block a percentage of rain (see map and photos reproduced from article; CC BY-NC 4 license). Forage production was more negatively affected by rain-out shelters in the more arid sites, and the responses were affected by loss of production of a few key species.

Herbivore dung promotes plant litter decomposition rate in a semi-arid grassland ecosystem

Wang, Y., Li, F.Y., Liu, Y, et. al. 2022. *Ecosystems*. In Press. <https://doi.org/10.1007/s10021-022-00784-3>

In a semiarid grassland of Central Inner Mongolia, litter mass loss and changes in nutrients were evaluated for two plant species and three herbivore dung types over two years. Horse dung decomposed most quickly, followed by cattle and lastly sheep. Dung, especially from cattle, promoted litter mass loss, nitrogen release, and loss of fiber from litter, provided the dung was below a certain relative litter and dung mixture. The mixture of herbivore dung with plant lit-



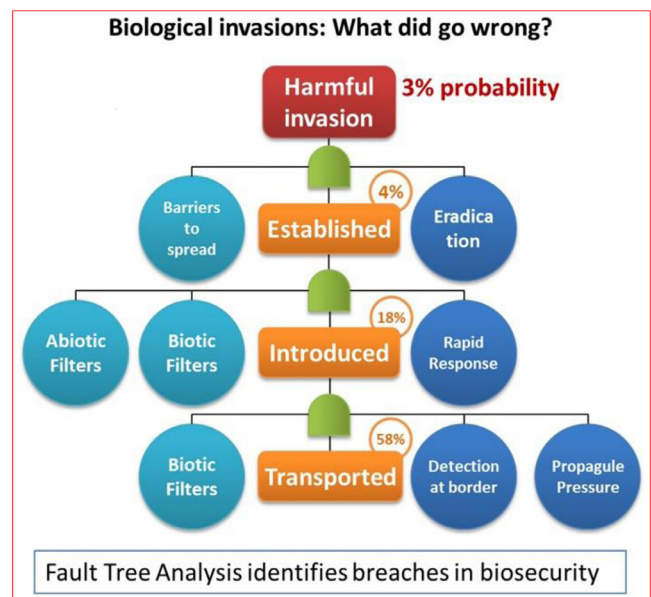
ter promotes litter decomposition, but it may inhibit dung decomposition.

A tool for research and management: invasions and biosecurity

Applying fault tree analysis to biological invasions identifies optimal targets for effective biosecurity

Gallardo, B., Sutherland, W.J., Martin, P., Aldridge, D. C. 2022. *Journal of Applied Ecology*. <https://doi.org/10.1111/1365-2664.14256>

Invasions by exotic plants and other taxa are one of the greatest threats to rangelands and identifying the causes of invasion is critical for effective management of the risks. These authors provide an example of how “fault-tree analysis” could be used to learn from past invasions to help optimize investment into blocking the chain of events (i.e., transport, introduction, establishment, spread, and development of impact) leading to severe exotic-invasion problems. The approach is applied to the Great Basin Non-Native Species Risk Assessments database, specifically for aquatic species using expert opinion. This figure illustrates an example of the outcome of the analysis (reproduced from article; CC BY-NC 4 license).



The approach is compared to probabilities of invasion estimated by the “tens rule” (i.e., 10% of non-native species can colonize a new area and 10% of the colonizers could become invasive).