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Research highlights

Recent scientific articles from the Agricultural Experiment Station campuses.



Dominic Sherony, www.flickr.com

Researchers found that grazed plots had more native plants than ungrazed ones and that all three bird species studied — Western meadowlark (*Sturnella neglecta*), Horned lark (*Eremophila alpestris*), and Grasshopper sparrow (*Ammodramus savannarum*, above) — had positive associations with native plant abundance.

Livestock grazing supports native plants and songbirds in a California grassland

California's grasslands provide fresh water, recreational opportunities, food, and climate mitigation benefits. They are also home to many species of native plants and wildlife, including a suite of grassland-dependent songbirds whose populations are declining precipitously across the western United States.

Livestock grazing is the most widely used tool to manage and restore grasslands. To better understand the effects of grazing on native plants and grassland bird habitat, a team of scientists led by James Bartolome, professor in the Department of Environmental Science, Policy, and Management at UC Berkeley, studied three bird species in central California — Western meadowlark (*Sturnella neglecta*), Horned lark (*Eremophila alpestris*), and Grasshopper sparrow (*Ammodramus savannarum*).

The researchers found that grazed plots had more native plants than ungrazed ones and that all three bird species had positive associations with native plant abundance. Their results suggest that livestock grazing in annual grasslands is compatible with, and may enhance, bird conservation in grasslands in Mediterranean climates.

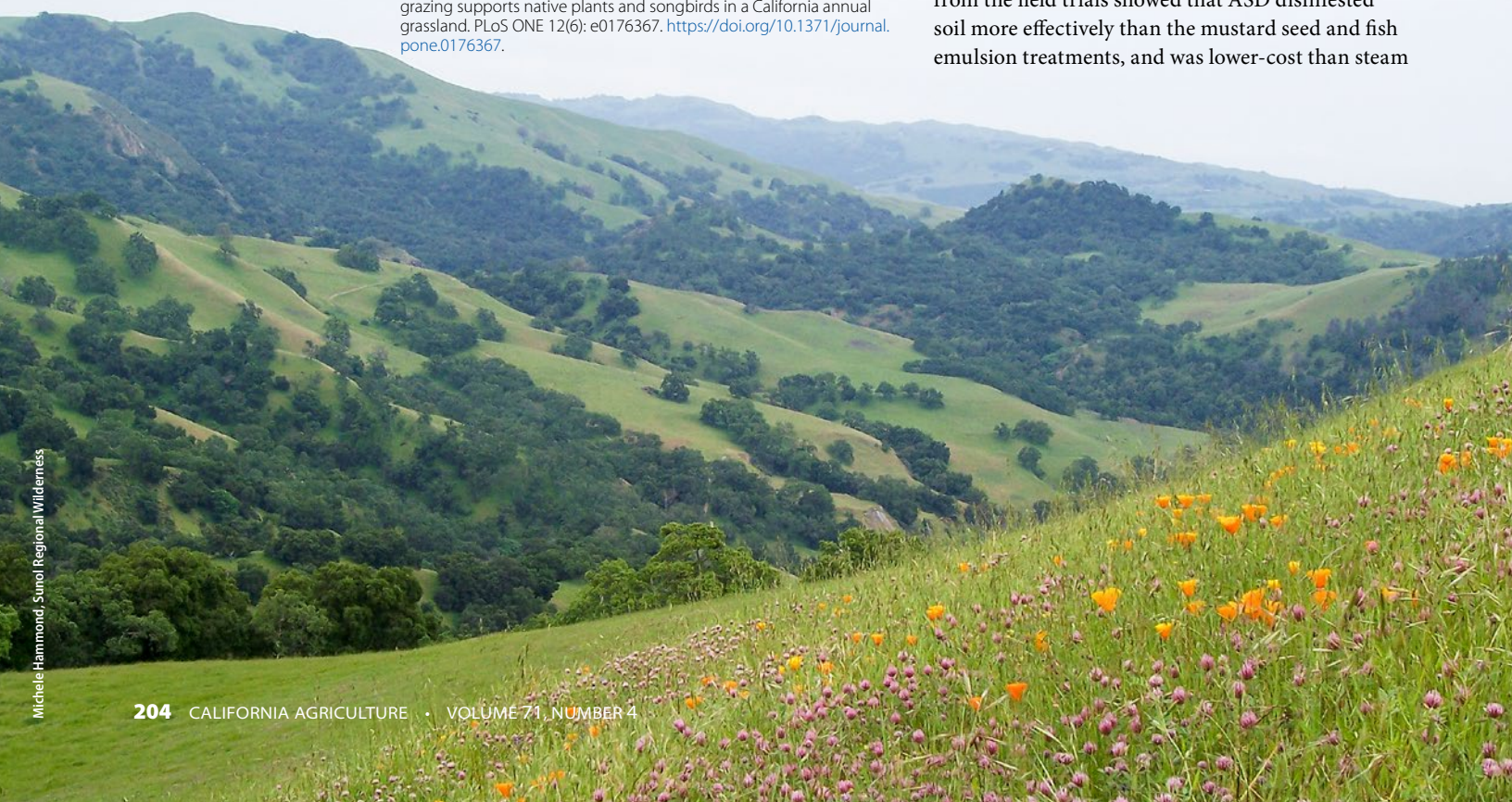
Gennet S, Spotswood E, Hammond M, Bartolome JW. 2017. Livestock grazing supports native plants and songbirds in a California annual grassland. PLoS ONE 12(6): e0176367. https://doi.org/10.1371/journal.pone.0176367.

Anaerobic soil disinfestation can be an effective and economical alternative to fumigation

For decades, California strawberry growers used methyl bromide to control soilborne diseases, nematodes and weeds in their fields. Use of the fumigant has been phased out, with the last strawberry applications in 2016. The use of other chemical fumigants, such as chloropicrin, has increased.

Because fumigants are heavily regulated and pose health and environmental risks, scientists are investigating alternatives to soil fumigation. In this study (Shennan et al. 2017), a group of UC, USDA and private sector researchers investigated the effectiveness of anaerobic soil disinfestation (ASD) in controlling pathogens, including the fungus *Verticillium dahliae*, the cause of verticillium wilt. The team conducted controlled-environment experiments of ASD, as well as on-farm field trials comparing ASD — using rice bran as a carbon source — with control treatments, along with other nonfumigant soil disinfestation treatments (steam treatment, "biofumigation" with mustard seed meal, and the application of fish emulsion).

Results from the controlled-environment trials showed the importance of soil temperature to the effectiveness of ASD: at soil temperatures of 15°C, ASD was ineffective, while at 25°C it was highly effective. Results from the field trials showed that ASD disinfested soil more effectively than the mustard seed and fish emulsion treatments, and was lower-cost than steam



Michele Hammond, Sunol Regional Wilderness





In field trials conducted on organic strawberries by Shennan et al., plants in plots treated with anaerobic soil disinfestation (ASD), *right*, were larger and produced higher yields than plants in untreated plots, *left*.

treatment. In three out of the four field trials, estimated cash returns from the ASD plots were 92% to 96% of those from beds fumigated with chloropicrin.

Steam currently appears to be the most effective nonfumigant soil treatment for strawberries, though it remains more expensive than ASD (see, e.g., Fennimore and Goodhue 2016 and Xu et al. 2017). Research on both techniques continues.

Shennan C, Muramoto J, Koike S, et al. 2017. Anaerobic soil disinfestation is an alternative to soil fumigation for control of some soilborne pathogens in strawberry production. Plant Pathol. https://doi.org/10.1111/ppa.12721.

See also:

Xu Y, Goodhue RE, Chalfant JA. 2017. Economic viability of steam as an alternative to preplant soil fumigation in California strawberry production. Hortscience 52(3): 401–7. https://doi.org/10.21273/HORTSCI11486-16.

Fennimore SA, Goodhue RE. 2016. Soil disinfestation with steam: A review of economics, engineering, and soil pest control in California strawberry. Int J Fruit Sci. https://doi.org/10.1080/15538362.2016.1195312.

Three decades of change in forest management

In this review article, a group of researchers including Professor Kevin O'Hara, Department of Environmental Science, Policy, and Management at UC Berkeley, highlight the changes that have influenced silviculture since 1986 and explore how it may evolve in the future.

One of the main takeaways from the past 30 years is that the magnitude of the changes could not have been anticipated. The expansion in management objectives to respond to environmental and social concerns is one such change: In addition to managing for sustained timber yield, the authors note, forest management now includes goals such as improving water quality and supporting biological diversity.

The authors also review the dramatic changes in forest conditions: an increasing number of megafires and the proliferation of invasive plants and insects, frequently the result of drought in combination with fire suppression and management policies. Other changes reviewed in the article include industry consolidation, the rise of conservation easements, and advances in tools for gathering and analyzing data.

D'Amato AW, Jokela EJ, O'Hara KL, Long JN. 2017. Silviculture in the United States: An amazing period of change over the past 30 years. J Forest. https://doi.org/10.5849/JOF-2016-035.

Biochar actively promotes soil carbon sequestration

Biochar is a carbon-based byproduct made, as charcoal is, by burning biomass in a low-oxygen environment. Adding biochar to agricultural soils shows promise as a way to sequester carbon; it also has been shown to improve soil quality in several ways, including reduced nutrient leaching and increased water holding capacity.

However, a variety of unknowns remain about the effect of biochar on soil properties such as structure, organic matter, chemistry and microbial communities, as well as the effects of differences in soil and biochar composition.

To address some of these questions, a team of UC Davis researchers conducted laboratory tests of two types of biochar added at multiple concentrations to two types of agricultural soils.

A key finding was that the biochar, by promoting the formation of stable aggregates of soil particles, actively promotes soil carbon storage. That is, it appears to contribute to soil carbon sequestration in two ways: it represents a recalcitrant sink of carbon itself, and it promotes changes in soil structure that help to keep existing soil carbon in the soil.

Wang D, Fonte SJ, Parikh SJ, Six J, Scow KM. 2017. Biochar additions can enhance soil structure and the physical stabilization of C in aggregates. Geoderma 303:110–7. https://doi.org/10.1016/j.geoderma.2017.05.027.

Multiaged mixed conifer stand in the Sierra Nevada.







Left, The Salton Sea is shrinking, exposing more of its playa, which contains a number of chemicals of concern. *Right*, UC Riverside graduate student Justin Dingle collects playa samples for source chemical characterization.

How the Salton Sea playa contributes to local air pollution

In the coming years, changes in water availability and management in the Imperial Valley are expected to decrease inflows to the Salton Sea, reducing its size and exposing large areas of dry lakebed, or playa.

Playas can be major sources of dust pollution. In addition, because of the high concentrations of metals and pesticides in the sediments of the Salton Sea, the dust from its playa raises toxicity concerns.

Roya Bahreini, associate professor of environmental sciences at UC Riverside, and her students and collaborators sampled dust in two communities on the shore of the Salton Sea to assess the playa's contribution to overall dust pollution in the region (measured as PM_{10}, particulate matter less than 10 microns in diameter) as well as its contribution of individual elements of concern, such as arsenic, selenium and sodium.

The playa contributed about 9% of total PM_{10} in the local air (in a region where particulate matter pollution already exceeds federal standards), and was the source of a large fraction of some airborne elements — for instance, 38% to 68% of the sodium in the air came from the playa.

The study found that the playa is not currently a source of airborne toxics at levels of concern for nearby population centers. However, as the Salton Sea shrinks, the playa will become a larger source of pollutants. In addition, high concentrations of elements such as sodium in dust can affect downwind soil composition in natural and agricultural systems significantly. The methods developed for the project can be applied elsewhere in the world to study air pollutants generated by playa systems.

Frie AL, Dingle JH, Ying SC, Bahreini R. 2017. The effect of a receding saline lake (the Salton Sea) on airborne particulate matter composition. Environ Sci Technol 51(15):8283–92. https://doi.org/10.1021/acs.est.7b01773.

How vegetation affects urban climates

Since the mid-20th century urban areas have been warming twice as fast as surrounding rural and wild areas, a phenomenon known as the urban heat island effect.

Vegetation in urban areas provides cooling, through shading as well as evapotranspiration. It can also increase relative humidity, which increases the heat index, a measure of human-perceived heat. However, the balance of these effects and their spatial variability within cities has been little studied.

To investigate these dynamics, Darrel Jenerette, professor of landscape ecology at UC Riverside, and his collaborators deployed networks of sensors in multiple locations with varying degrees of vegetation cover along a coastal to inland desert gradient in Southern California.

They found the effect of vegetation on air temperature to be substantially greater at night than during the day, likely due to daytime shading that reduces the buildup of heat energy in asphalt and other built surfaces, which continue to release heat to the air after the sun sets. This nighttime cooling effect increased further from the coast as average temperature increased. Vegetation-related cooling also reduced the heat index, despite an increase in relative humidity.

The results also suggest an important for role for wind in determining the local temperature effect of vegetation cover; through mixing, wind can reduce the air temperature difference between vegetated and non-vegetated areas. Hot days in Southern California typically result in reduced wind near the coast but increased wind inland, and the temperature variability readings gathered by the researchers were consistent with a wind-mixing effect.

Crum SM, Shiflett SA, Jenerette GD. 2017. The influence of vegetation, mesoclimate and meteorology on urban atmospheric microclimates across a coastal to desert climate gradient. J Environ Manage 200:295–303. https://doi.org/10.1016/j.jenvman.2017.05.077.